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A TREATISE

ON

MILITARY SURGERY

AND

HYGIENE.

BY

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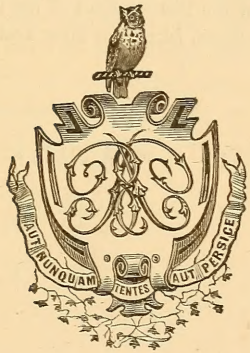
Illustrated with 127 Engravings.



NEW YORK:

BAILLIÈRE BROTHERS, 520 BROADWAY.

LONDON:
H. BAILLIERE,
REGENT ST.

MELBOURNE:
F. BAILLIERE
COLLINS ST.

PARIS:
J. B. BAILLIERE ET FILS,
RUE HAUTEFEUILLE.

MADRID:
C. BAILLY-BAILLIERE,
CALLE DEL PRINCIPE.

1865.

Entered according to Act of Congress, in the year 1865, by
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R. CRAIGHEAD, PRINTER,
Caxton Building,
81, 83, *and* 85 *Centre Street N. Y.*

To

MAJOR-GENERAL E. D. KEYES, U.S.A.,

Late Commander of the Fourth Corps,

WHOSE CONSTANT ATTENTION TO THE INTERESTS OF THE SICK AND WOUNDED SOLDIER, NO LESS THAN HIS GALLANTRY ON THE FIELD, HIS UNTIRING VIGILANCE IN PRESENCE OF THE ENEMY, AND HIS STERN LOYALTY, HAVE WON FOR HIM THE CONFIDENCE AND ESTEEM OF ALL WHO KNEW HIM INTIMATELY, THIS VOLUME IS RESPECTFULLY DEDICATED BY

The Author.

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PREFACE.

At the commencement of the present war, I published a short treatise on Military Surgery, intended only to supply the immediate and pressing wants of those young men who were then for the first time entering upon the duties of Army Surgeons. The edition was soon exhausted; but unremitting engagements in the public service prevented a revision of its pages, and the republication was consequently delayed. Having at length undertaken the revisal, it was found that four years of war had opened so many questions of interest, that the limits and scope of the original volume were inadequate to their consideration; and instead of a new edition, an entirely new work was demanded.

It is thought necessary, however, to inform the reader that this volume does not pretend to furnish a complete record of the experience of our Army Surgeons. This can only be obtained when the Medical Bureau, at Washington, shall have completed its labors, and the Government shall have authorized the publication of its official reports. The duty of arranging and of compiling these reports has, by the Surgeon-General, been placed in competent hands, and they will in due time be given to the profession. Meanwhile the only sources of information which are open to the public are the occasional unofficial communications found in our Medical Journals. Of these I have availed myself as far as possible. To my personal friends, also, the volume is indebted for many valuable observations, and for reports of interesting cases.

The wood-cuts are in part from original drawings. The illustrations of amputations and exsections are essentially the same as those employed in Dr. Stephen Smith's excellent "Hand-Book of Surgical Operations," and for which he has acknowledged his indebtedness to several writers. Some of these I have changed to suit my own views; and a majority of them have been so much altered from the originals, in passing from one book to another, that I doubt very much whether the authors would recognise them as their own, or would care to receive any more precise acknowledgment. If in any case this proper act of courtesy shall seem not to have been satisfactorily performed, it is hoped that the omission will not be charged to an intention to misappropriate the labor of others.

The chapter on "Hospital Gangrene" has been contributed by Frank H. Hamilton, Jr., A. A. Surg., U.S.A., whose experience in the treatment of this malady has been such as to render his opinions of especial value.

FRANK H. HAMILTON.

January 2, 1865.
64 *Madison Avenue, New York.*

MILITARY SURGERY.

CHAPTER I.

INTRODUCTION.

War is the normal condition of mankind; peace is the abnormal condition. This statement is not flattering to a people claiming Christianity and boasting of its civilization; it is nevertheless true, and the fact must be accepted. History is little else than a record of the contentions, conflicts, and conquests of nations. The sword and the cross, conventional emblems of battle-fields, stand as thick upon the round surface of the terrestrial sphere as stars upon the surface of the celestial. Each year, and almost every month in the year, commemorates some new achievement of arms, and places a new symbol upon the map; so that now, in the middle of the nineteenth century, as when Isaiah wrote, it is only in prophetic vision that we see the approach of that happy day when "swords shall be beaten into ploughshares and spears into pruning-hooks, and nations shall not learn war any more."

We must not be surprised, therefore, that a great part of mankind have occupied themselves, and still continue to occupy themselves, in the improvement and perfection of the art of war; nor that it has come at last to take rank almost among the exact sciences. It has been the

study especially of kings, princes, governors, statesmen, philosophers, and military chieftains, who have created for it a factitious, but universally conceded, nobility, by virtue of which it takes precedence of all other sciences, while it condescends, in order to the attainment of its selfish ends, to impress them into its service.

But surgery, like many other departments of knowledge which have been compelled to submit to this tyranny, and to contribute reluctantly to the perfection of a barbarous art, has, in its application to the purposes of war, we are happy to say, other and more legitimate ends. It is equally the mission of the Military Surgeon to prevent, as far as possible, all useless expenditure of life. In civilized warfare life is spared whenever a firelock is grounded, or an arm is disabled; and, so well is this understood, the wounded soldier does not hesitate to throw himself upon the mercy of his captors for surgical aid, since he is equally certain of receiving succor from the surgical corps of a foe as of a friend. Consider how much this serves to soften the savage aspect of war; that if battles must be fought, the results should be obtained with as little sacrifice of life, with as little mutilation and suffering as possible. The world is indebted to our profession for this.

At the same time, also, many excellent surgeons bring away from these great schools of practice valuable lessons of experience, which, being carefully written down, are of service to those who live after them. Waterloo, Sevastopol, and Solferino, witnessed each a terrible slaughter of human beings; but let us hope that in the faithful "annals of their sufferings," recorded by Larrey, Guthrie, Hennen, Armand, and others, the world will find some compensation, if not actual occasion for gratitude, since they have added so many new fasciculi to our stores of knowledge;

and since it is not impossible the lives which will be thereby saved will outnumber the lives which were lost in those battles. "It is one of the happy privileges of the military surgeon," says Armand, "to draw from the state of war precepts which console humanity, by turning to his profit the observations and the treatment of the maladies which follow in its train."

Military and naval surgery is not a new and distinct science, but only the science of medicine in its largest sense, with a special application. The principles of civil and military surgery are the same, or nearly the same; but the application of those principles is varied or modified, according to the varying exigencies of the case. Anatomy, physiology, chemistry, botany, and pharmacy, lie at the foundation of each; and what of these has been learned in the schools is equally applicable to both. So also the sciences of military practice, military surgery, and military hygiene, are nearly identical in their fundamental laws with the civil sciences so named; but they differ occasionally in their subordinate rules; more often in their modes of procedure, and in the use of means by which they seek to accomplish the same ends. But perhaps the widest difference will be found to consist in the relative frequency of certain accidents and diseases; insomuch that what is of daily occurrence, and a common experience in the one, is rarely seen in the other, and the reverse.

A few examples will illustrate these important differences. It is well known that certain conditions of the limb generally demand amputation in military practice; as, for example, a gunshot wound traversing a large joint; while the same conditions do not necessarily exact the same sacrifice in civil practice. This change or modification of the rule evidently has reference to the altered condition of

treatment to which the soldier and civilian will probably be subjected.

In civil practice, the time occupied in any operation, especially since the introduction of anæsthetics, is generally regarded as a matter of secondary importance. And that mode which possesses even trifling points of superiority with reference to the final result, even though more tedious in its execution, justly claims the preference. Here we may properly apply the maxim, "sat cito, si sat bene." But in military practice, at least in most operations made upon the field, and where, as is usually the case, the number of surgeons is small in proportion to the number of wounded, time is of the first importance, and minor preferences must yield to major necessities. It will not do to let one man die of hæmorrhage from the femoral artery because you wish to apply a ligature very methodically to the ulnar artery of another; nor to amputate a limb by circular incisions, when by oval incisions it can be done in half the time. Armand, whose noble sentiments one is frequently compelled to admire, speaking of his experience as surgeon to the ambulance of the Imperial Guard during the Crimean war, observes, "In ordinary times of the siege, the local barracks, or the tents, sufficed. In the grand engagements, the encumbrance of the wounded was such that it became necessary to gather them into groups here and there; and God knows, then, how painful was the mission of the surgeons, who were compelled to multiply themselves to succor the hundreds, the thousands of the wounded constantly imploring their aid!" There was but one precept then, "*Cite!* citissime!"

Broken limbs, when dressed in the midst of an engagement, cannot exact the same amount of care and attention in their adjustment as in a well supplied hospital, or as in

ordinary private practice. The appliances must be simple, few, and, in many cases, measurably inadequate. They must be adapted especially to the conditions requisite for transportation. Complicated double-inclined planes, pulleys, and swings, however useful they might be for limbs at rest, are wholly inapplicable to those cases in which the patient has to be transported long distances in wagons and over rough roads. The most enthusiastic advocate of Pott's treatment of broken limbs, without side splints or extension, would never be so absurd as to claim for it a preference under these circumstances.

General treatises upon surgery and surgical teachers, assume that both the patient and his medical attendant are placed always under the most favorable circumstances: that ample time is allowed for a careful diagnosis; and, in view of an operation, that the patient is brought up to the best possible condition of preparation: that he is at least comfortably lodged, suitably nourished, and that his surgeon has at his command all the instruments and appliances which can render the execution of the operation more easy and its success more certain. No man who has had much experience in teaching, and in examining medical students, can have failed to notice the danger of suggesting inferior alternatives for exceptional cases, which, through inattention or carelessness, are often substituted in the minds of the pupil for the general law; and it is with much propriety, therefore, that these omissions are generally made.

It is the special province of military and naval surgery to supply these deficiencies; instructing the pupil how, by a multitude of extemporaneous expedients, he may succor the wounded and relieve the sick when the usual resources fail or are not at hand; how he may make the products of

every country contribute to his necessities, and a single cruse of oil minister miraculously to a thousand.

As we have intimated, however, the widest difference between civil and military surgery is to be found in the relative frequency of certain accidents and diseases. Club-feet, rickets, hip-disease, and strabismus, are of every-day occurrence in domestic and city hospital practice, while they are almost unknown to army practice. On the other hand, scurvy, gunshot, sword, and bayonet wounds, pyæmia, and hospital gangrene, are rarely met with in the first, while they are common in the second.

Such as remain sceptical upon this point have only to enter successively the wards of a military and of a civil hospital; to compare with each other a civil and a military dispensary; or examine the private records of a civil and of a military surgeon, to convince themselves that the two schools do not furnish, relatively, the same instruction.

In order to be prepared, also, for all the duties imposed upon an army surgeon, one must understand what are the peculiar physical qualifications necessary to become an efficient soldier—what conditions imply health, endurance, agility, and we may add, courage. It is the first part of a military surgeon's duty to select and arrange the tools by which the work is to be done, and the remainder of his duty is to keep these tools in order.

Will any one say that our services are unimportant, and our position a subordinate one in the business of war? The fact is, that neither tactics nor strategy will serve an army of invalids. These men perish or are demoralized when no enemy is opposed to them; and more than one campaign, which opened auspiciously, has been brought to a disastrous close in consequence of the injudicious selection of recruits, and of the lack of suitable provisions on

the part of the government or of the officers for the preservation of their health. The mortifying termination of several campaigns, especially at the North, during the war of 1812 in this country, sufficiently demonstrates the truth of these assertions.

Feigned diseases, also, need to be studied. They bear the same relations, in military surgery, to actual diseases, as sophisticated drugs bear to the genuine; and to occupy a position of trust in the medical staff of the army, without some knowledge of the ingenious dissimulations practised by soldiers to relieve themselves from duty, or to obtain a discharge and a pension, would be as unjust to the public whom you serve as to undertake the duties of a pharmaceutist or of a drug-inspector, without any competent knowledge of the art of sophistication.

The diet, dress, and general hygiene of the troops; the transport of the sick and wounded; the construction and location of tents, barracks, and hospitals, with a view to their healthfulness; the arrangement of bivouacs; are among the subjects which properly belong to this branch of surgery.

Finally, as not the least valuable of those accomplishments which ought to adorn an army medical officer, we must not omit to enumerate a thorough knowledge of geography, climatology, meteorology, geology, and botany, with many other kindred subjects belonging to the natural sciences.

While improvements are being constantly made in the construction of firearms and of other weapons of warfare, and the art of war is advancing step by step towards the complete attainment of its purpose, it is delightful to observe how steadily, yet silently, the genius of medicine follows upon its heavy tread. The introduction of gun-

powder as an instrument of war, was soon followed by the discovery and application of the ligature to wounded arteries after amputations. So that if thereafter the soldiers were not permitted to escape the terrible wounds inflicted by bullets and "fiery balls," they were saved from the more appalling infliction of having their mutilated stumps plunged into boiling pitch, to arrest the bleeding. And in our own day, the conical bullet and the rifled cannon have been overtaken by the discovery of the anæsthetic properties of chloroform and of ether.

The establishment of flying or field ambulances has also contributed greatly to the amelioration of the condition of the soldier, and, it may be said, to the efficiency of the service.

They are usually composed of the medical staff and picked men, who hang upon the rear, and press themselves into the very shadow of the advancing columns; and while the surgeons, with their assistants, stationed here and there in places of partial security, are prepared to render prompt surgical aid, the men who are especially charged with that duty, bring the wounded in panniers and upon litters to the several regimental depots.

The practice of employing field ambulances is now almost universal, but the plan of organization is much varied by different nations.

Richter, Physician General to the 8th corps of the Prussian army, who has devoted much attention to this subject, and to whose suggestions the Prussian army is indebted for its present excellent system of field ambulances, informs us that Austria, ever since the Italian and Hungarian campaigns, in 1848 and 1849, has employed with great success "*des troupes de santé*," and that this institution has been imitated in Bavaria, Saxony, and Hanover.

The Prussian system, established by royal ordinance in 1854, deserves to be especially mentioned. The "*Compagnies des porte-malades*," as they are sometimes called, are composed of one captain, three lieutenants, three assistant surgeons, with the rank of lieutenants; two hundred and three men, of which seventeen are non-commissioned officers, including a sergeant-major and a quartermaster; sixteen exempts (premiers soldats) and six buglers.

Each company is divided into three squads, that is to say, one squad for each hospital ambulance of the three grand divisions of the army. Each squad is composed of ten officers and one assistant surgeon, each of which is furnished with two horses; five non-commissioned officers, sixty soldiers and exempts, and two buglers.

Each squad has fifteen litters, equal to forty-five for the whole company.

In the American service the system of flying ambulances has, until recently, been much less complete and perfect in its details. The only assistance which a regimental surgeon and his adjuncts could claim upon the field of battle, was that of the band, and of a hospital orderly, who, by an order of the army board, made in November, 1859, was required to accompany the medical officer whether upon the march or in the field; the orderly carrying upon his back a knapsack, in which were placed such instruments, dressings, and medicines as might be needed in an emergency.

As to the value and importance of a well regulated system of field ambulances, it might be sufficient to say, that all of the army surgeons are agreed upon this subject, and its claims have been repeatedly urged by Percy, Hennen, Guthrie, Larrey, Jackson, Armand, Richter, Mann, and others, and that by most of the enlightened governments

of Europe they have been adopted and carried out to an admirable degree of perfection.

It will not be denied that humanity, and a just policy of economy, dictate that the wounded should receive succor as soon as possible, and that for this purpose the surgeons, with their assistants, ought to be stationed as near to the field of action as is consistent with their own safety, and the safety of those who are under their charge; nor will it be doubted that soldiers and officers will be less reluctant to expose themselves to the hazards of a battle when they feel assured that competent surgical aid is at hand. Whatever may be a man's apparent disregard of life, experience shows that most men, even when in heat, would of the two, rather kill their antagonist than die themselves. To be wounded may be honorable, but to die perchance is unnecessary. And better soldiers than Falstaff—nor is it any reflection upon their courage to say so—have probably uttered his soliloquy upon the eve of battle: "Can honor set to a broken leg? No. Or an arm? No. Or take away the grief of a wound? No. Honor hath no skill in surgery, then? No."

There is a single incident in the life of Ambrose Paré, which, having been often mentioned by historical writers, is probably familiar to all, but which, as furnishing a pertinent illustration of the confidence inspired in a whole army by the immediate presence of a skilful surgeon, merits a repetition at this time.

The ancient city of Metz was at one time besieged by an army of one hundred thousand men, commanded by Charles the Fifth in person. Within the walls were gathered a multitude of men, including nearly all the princes and nobility of France. Decimated by famine, disease, and by wounds received in the protracted defence, the garrison

was reduced almost to extremities. At this critical juncture the king sent to them his own surgeon, the great Paré, who had been successively surgeon to four kings of France, and who had during this period followed the French armies in all their campaigns. He was introduced into the city at night, by an Italian captain, and on the following morning being requested by the governor to show himself upon the breach, he was received by the soldiers with shouts of triumph. "We shall not die," they exclaimed, "even though wounded—Paré is among us!" From this time the defence was conducted with renewed vigor; and to the presence of this single man it has been universally conceded that the city was indebted for its salvation, although the siege was not raised until "the gallant army which lay around it had perished beneath its walls."

The value of medical services to an army, in a strategic, economical, and humane point of view, is indisputable.

The only real question, then, is as to the best mode of getting the soldiers wounded in battle to the hospital depots.

A considerable proportion find no difficulty in reaching the depots without assistance; and it is wonderful sometimes through how small a wound a large amount of courage will ooze out. The slightest prick of a bayonet or the loss of a finger will cripple some men and send them halting to the rear. These soldiers will take care of themselves.

But when a man falls who is seriously wounded, and not killed outright, it has been a common practice in both the American and British service for the officer in command to order a couple of soldiers to carry him off. This withdrew three men from the line instead of one. But unfortunately

it is well known that soldiers do not always wait for this authority. The commanding officer is not always where he can observe the conduct of all of his men; and impelled by the instinct of humanity, they, in many instances, cheerfully anticipate the supposed wishes of their officers, and seizing their fallen comrade they bear him hastily from the field. The effect of this is most demoralizing; for while it actually and materially diminishes the force of the column, it diverts the attention of the soldiers and of the officers from their first purpose, especially by substituting the more delicate and enervating sentiments of humanity for those coarser but more stimulating passions, revenge and ambition, by which the courage of troops is chiefly sustained.

Ballingall says: "We find the Duke of Wellington, in his general order, cautioning the commanding officers of regiments, and the officers and non-commissioned officers of companies, to take care that no man falls out of the ranks under pretence of assisting the wounded, when he is not ordered to do so by his officer;" and Mr. Alcock states that he has seen "in less than an hour, a whole battalion tail off after some fifty wounded."

There are many circumstances under which the escape of the wounded soldier from the mêlée of the conflict is impossible; and in which the incessant pressure of troops from the rear presents no alternative but to be trodden under foot by men and horses, or to be crushed by the wheels of the cannon. If, however, the storm of battle has in some measure passed over, and the wounded man is on that side of the clouds from which the rainbow can be seen —and it is to such alone that assistance can ever be offered —then he may be easily rescued by the soldiers of the ambulance, and borne upon a litter to a place of safety.

The army will, in this way, be separated into two distinct yet very disproportionate bodies; the one being occupied solely in killing, maiming, and mutilating, and the other in ministering to the sufferings of the wounded: thus no infection will be communicated from one to the other, and the morale of both will be preserved.

The experience of the first years of the present war in the United States demonstrated fully the insufficiency and defects of the ambulance system then in existence; and so early as the sixth of August, 1862, at the suggestion of Surgeon Jonathan Letterman, then Medical Director of the Army of the Potomac, the commanding officer, Major-General McClellan, ordered the establishment of a more complete system, and this order was carried into immediate effect. The same general plan, with only slight modifications, has continued in operation ever since in that army; and we are happy to say that, by a recent act of Congress, it has been extended to all the armies of the United States.

We shall take the liberty of quoting from the *American Medical Times* an abstract of the present U.S. Army ambulance system:

"The corps is a unit, and the supreme control of the ambulances is confided to the Medical Director of the army corps. The ambulances are in the proportion of three to a regiment; three men are assigned to an ambulance—one driver and two stretcher-bearers. This gives nine men to a regiment, who are commanded by a non-commissioned officer mounted. The above constitutes the regimental ambulance corps, which, consolidated by brigades, are commanded by a Second Lieutenant. The brigades are consolidated into divisions, commanded by a First Lieutenant, who consequently has under his command two Second Lieutenants, fifteen Sergeants, and one hundred and thirty-five men. The three divisions consolidated make the corps commanded by a Captain, under the immediate com-

mand of the Medical Director. There is one light medicine wagon, and three six-horse supply wagons for each brigade. When a movement is ordered, the sick are taken up by the trains of their respective divisions, the regimental hospital wagons are ordered to join the trains, and thus the whole of the hospital appliances of each division, in one compact column, follows close upon its own division, under the command of the Ambulance Officer. Two medical officers, with steward and nurses, are detailed to accompany the train and to take charge of the sick in it. Upon halting, hospital tents, to the number sufficient to accommodate the sick, are pitched, a hospital is rapidly established, all the aid necessary being rendered by the ambulance corps; the train and hospital are close to the camp of the division. In battle the stretcher-bearers march with the regiments to which they belong, into the action. The Medical Director, with the Captain of the Ambulance Corps, is with the General commanding the corps, at the front. As soon as the positions into which the divisions in battle will be thrown are ascertained, the Medical Director communicates with the Surgeon-in-Chief of division, designating the places where the division hospitals are to be located. These hospitals are composed of the hospital tents in the division, together with a house or barn, if available. The ambulances are drawn up between the hospitals and the division in front, awaiting orders. One officer of the ambulance train is with the Division Commander, one non-commissioned officer with each brigade. The Medical Officers who accompany the regiments into action take position by brigades, in some sheltered location contiguous to their respective brigades. This position is known to the Sergeant watching the brigade, who directs the wounded with stretcher-bearers thither. The ambulances are ordered up to the same place, to take the wounded to the division hospitals in the rear. The officer at division headquarters, as soon as the action begins, orders up the ambulances and designates the point to which they are to go. He learns from the Medical Director or Corps Officer the various positions and shiftings of the troops, and acts accordingly. In this manner the operations of the Ambulance Corps are conducted throughout the action and subsequent to it, until all the wounded are removed from the field to the division hospitals in the rear, where they receive professional and all other treatment necessary."

The field hospital system of the Army of the Potomac and the arrangements in the purveying department, have also been extended, with but slight modifications, by the Surgeon-General to all the armies of the United States.

The hospital system is as follows:

"Previous to an engagement, there is established in each corps a hospital for each Division, the position of which is selected by the Medical Director of the corps. The organization of the hospital is as follows:—1st. A Surgeon in charge; one Assistant Surgeon to provide food and shelter, etc.; one Assistant Surgeon to keep the records. 2d. Three Medical Officers to perform operations; three Medical Officers as assistants to each of these officers. 3d. Additional Medical Officers, Hospital Stewards, and Nurses of the Division. The Surgeon in charge has general superintendence, and is responsible to the Surgeon-in-Chief of the Division for the proper administration of the hospital. The Surgeon-in-chief of Division details one Assistant Surgeon, whose duties are to pitch the hospital tents and provide straw, fuel, water, blankets, etc., and organize a kitchen. The Cooks, Hospital Stewards, and Nurses are placed under his orders. Another Assistant Surgeon keeps a complete record of every case brought to the hospital, and sees to the proper interment of those who die. The Surgeon-in-chief, under the direction of the Medical Director of the corps, selects three medical officers as the operating staff of the hospital, upon whom will rest the immediate responsibility of the performance of all important operations. In all doubtful cases they consult together, and a majority of them decides upon the expediency and character of the operation. These officers are selected *solely* on account of their known prudence, judgment, and skill. Three Medical Officers are detailed to act as assistants to each one of these officers, one being selected to administer the anæsthetic. The remaining Medical Officers of the Division, except one to each Regiment, are ordered to the hospitals to act as dressers and assistants generally.

"The Surgeon-in-chief of the Division exercises general supervision, under the Medical Director of the Corps, over the medical affairs in his division. He must see that the officers are faithful in

the performance of their duties in the hospital and upon the field, and that, by the ambulance corps, the wounded are removed from the field carefully and with dispatch. Whenever his duties permit, he gives his professional services at the hospital; orders to the hospital, as soon as located, all the hospital wagons of the brigades, the hospital tents and furniture, and all the hospital stewards and nurses; notifies the Captain commanding the ambulance corps, or, if this be impracticable, the First Lieutenant commanding the Division ambulances, of the location of the hospital. No medical officer is allowed to leave the position to which he has been assigned without permission. No wounded are sent away from any hospital without authority from the Medical Director of the Army. Previous to an engagement, a detail will be made by Medical Directors of Corps of a proper number of Medical Officers, who will, should a retreat be found necessary, remain and take care of the wounded.

"The following regulations were established for the purveying department:—There are allowed the following supplies to a brigade for one month, for active field service, viz.:—One medicine wagon, filled; one medicine chest for each regiment, filled; one hospital knapsack for each regimental Medical Officer, filled. The Surgeon-in-chief of each Brigade requires of the Medical Purveyor these supplies, and issues to the senior Medical Officer of each regiment in his Brigade the medicine chests and knapsacks. The Surgeons-in-chief of Brigades issue to regimental Medical Officers such of the supplies from the medicine or army wagon as may from time to time be required. These issues are informal, the Surgeons-in-chief giving no invoices, demanding no receipts, but accounting for them as expended. These officers are especially directed, when they shall have drawn the monthly supply, not to divide it out among the regiments, but only to issue the articles at such times and in such quantities as they are needed for use, or to keep the medicine chests and knapsacks supplied. Supplies are only issued by the Medical Purveyor upon requisitions approved by Medical Directors of Corps, and these officers are particularly enjoined to revise all requisitions with care, that sufficient supplies may be on hand, and yet that no unnecessary expenditure be permitted. As far as possible, requisitions will be made but once a month, and special requisitions avoided as far as practicable. The supply allowed will be kept up, and Medical Directors will see, espe-

cially before a march or a battle, that timely requisitions are made and the supplies obtained. Should the welfare of the sick demand a greater amount than is given by the table, or for articles which are not allowed by it, they are given upon a proper requisition. The tables which follow afford a very liberal allowance of a large list of remedies.

"Such is an outline of the reorganization which Dr. Letterman effected in the Army of the Potomac. It will be seen that the reforms were radical, and developed under different heads a system of operations which covered the whole field of medical service. Its utility consisted in reducing to harmony and concert of action every branch of the medical service, and in placing the right man in the right place. Unity and efficiency was the key-note of the reform proposed, and to this every other consideration had to yield. The entire Medical Staff of the army became a unit, and moved with the deliberation and precision of a single person. Of the practical value of these improvements we are now able to speak in the most unqualified terms. They have been put to the most rigid test, and have been found in the highest degree practical and effective. The Medical Staff of no army ever worked in such perfect harmony and subordination on the battle-field as that of the Army of the Potomac. The battles of South Mountain, Crampton's Gap, Antietam, Fredericksburg, Chancellorsville, and Gettysburg, have placed the most violent strain upon every detail of this organization, whether taken as a whole or in its separate parts, and yet it has never been found wanting. The prompt care of the wounded in these sanguinary battles was never exceeded under similar circumstances."

To these judicious remarks of the editor of the *Times* we have to add our own testimony, having witnessed the operation of these several departments of field service, both in the Army of the Potomac and in the Army of the Cumberland, and we can attest that nothing could exceed their efficiency. It was our privilege to have been one of the six Corps Medical Directors who, by invitation of Surgeon Letterman, first met on the 7th of July, 1862, at Harrison's Landing, Va., to consult in reference to these

and other matters. We found, however, that his plans were already very fully digested and matured, and on the 8th of August following, one month later, they went into effect. We take pleasure in declaring that, in our opinion, the Armies of the United States are indebted to Surgeon Letterman solely for one of the best systems of Medical Field Service which has ever yet been devised.

Ever since the establishment of a medical department in connexion with armies, or until within a very recent period, it has been customary to consider and hold the medical officers, of whatever grade, as subordinate to the other branches of the service—conferring upon them neither rank nor authority in any case. The practice has been thought to be unjust to an honorable profession, and of doubtful utility to the public interest; and from time to time the subject has been pressed upon the consideration of the various governments by distinguished army surgeons, both in this country and upon the continent of Europe, whose representations have had the effect, in many cases, of bringing about certain manifest improvements, although they have failed anywhere to accomplish all that is desired.

In relation to rank, probably the most decided step in advance has been made in our own country by the Act of Congress approved Feb. 11, 1847, which declares that, "the rank of the officers of the Medical Department of the Army, shall be arranged upon the same basis which at present determines the amount of their pay and emoluments: Provided, that medical officers shall not, in virtue of such rank, be entitled to command in the line or other staff departments of the army."

This was a well considered and enlightened act of legislation, intended to remove the medical officers from that

position of subordination where they had so long been subject to petty annoyances, and even to the insults of inferior officers of the line, and to secure for them those courtesies, and that respect, which they had a right to claim. It conferred no authority to command, nor any privileges which one gentleman should ever hesitate to concede to another; but it is well known that, from the time of the passage of this act until the present moment, a few officers of the army and navy have persistently refused to recognise its obligations, and that they have habitually and openly violated both its spirit and its letter.

We wish especially to exonerate from this charge the great body of the army and navy officers, by whom the medical officers have been uniformly treated with the greatest courtesy. The exceptions, however, have been found to be sufficiently numerous, in which the officers of the line have refused to comply with the law, to call forth repeated remonstrances from the surgeons, and to render it proper in the opinion of Surgeon-General Lawson to issue a circular, recommending to medical officers a conciliatory but decided stand, reminding them that "encroachment promptly met will be more promptly checked; while any evidence of irresolution, or want of confidence in the correctness of their position, might lead to further aggression."

We understand those who have refused a compliance with the law to say, in justification, that surgeons are non-combatants, and that to combatants alone, upon whom, they affirm, rest the hazards and responsibilities of war, rightly belong its honors.

This distinction has been made before, and it has been the constant pretext for opposition to the conferring of rank upon medical officers; yet we deny that it has any

foundation in fact, and it is plainly calculated, if it is not intended, to depreciate our position and to underrate our service. Says Dr. Tripler: "The old distinction between combatants and non-combatants, as applied to the medical officer, has been roughly handled, and in not a few instances scouted as absurd, by officers of the highest rank in the British army. In our own army they are the only officers of the administrative branches of the general staff whose duties require them to be present on the field of battle. In the brilliant campaign of Gen. Scott in Mexico, the medical staff was the only one that had an officer killed or wounded. No officer of the Quartermaster or Subsistence Department was either killed or wounded. To any one who understands the meaning of terms, and the duties of these departments, to call one of them combatants in contradistinction to the other, as a pretext for conferring military rank upon that one and denying it to the other, is simply absurd. We may say as Cicero did of the Roman augurs: 'We cannot see how two men, maintaining that opinion, can look each other in the face without laughing.'" Dr. Tripler properly adds: "Inveterate habit in the abuse of terms has drifted us thus far unresistingly with the notion that the Commissary of Subsistence, who purchases provisions in Cincinnati for the subsistence of the soldiers, is a combatant, while a medical officer is officially a non-combatant."

If exposure to hardship and danger is to be the ground upon which rank is to be conceded to officers of the army or of the navy, we think the claim of the medical officers may be easily determined. The medical officers are exposed to the same hardships on the march or in cantonment as the officers of the line; and while the latter have to incur the hazards of battle only occasionally, perhaps

but once in a campaign, the former may be said to be doing battle daily, being constantly subjected to the dangers of pestilence by their exposure to the contagions and infections of crowded and unwholesome hospitals. We have not the statistics before us upon which to base a positive statement, but we entertain little doubt that, were the facts known, it would be found that in proportion to the number employed in any campaign, the number of deaths, or of invalided in the medical staff, by the ordinary casualties and exposures of the service, is greater than in any other department.

But as compared with the quartermaster or subsistence officers, the hazards of the medical officers are undeniably greater. The services of the first are never required upon the field; while the surgeons are expected to accompany their respective regiments until the action commences—and then only to retire to some position of comparative, but not absolute safety. The instances upon record in which medical officers have been wounded and killed upon the field of battle, when in discharge of their appropriate duties, are numerous. In savage warfare very little respect is usually paid to any theoretical distinctions between combatants and non-combatants; and in civilized warfare the distinction is by no means constantly observed by an excited and disorderly soldiery.

Surgeon Dunigan, writing from the Crimea during the siege of Sevastopol, states, "already one medical officer has been killed and two or three wounded. The first, Mr. O'Leary, Assistant Surgeon of the 68th Regiment of Light Infantry, was actually cut in two by a cannon-ball while in the act of assisting a wounded seaman. It is only to be wondered at that more casualties have not occurred among the medical officers, for during the heat of the fire they are

constantly called from place to place, running along the batteries, through the line of fire, in quest of the wounded. During the second bombardment this peripatetic system was very trying and fatiguing, for the soil was heavy and tenacious from the torrents of rain that then deluged the trenches; and instances occurred where officers' boots drew off while running along to assist the wounded * * * On the whole," he remarks, "this trench duty is very trying and hazardous; and in performing it, the medical men run the same dangers, if not more, certainly not less, than the executive officers, who are generally stationary in a battery, while the medical officer, as ubiquitous as possible, is rushing in all directions to succor the wounded."*

The life of Larrey was frequently exposed to the most imminent hazards upon the field of battle. At Waterloo he was taken prisoner, and was upon the point of being shot, after having been robbed of his watch and purse, when he was recognised by a Prussian surgeon, and his life saved.

We wish, moreover, to remind the officers of the executive department of the army, that while there are many points of antagonism between their duties and those of the medical department, there are also some points of parallelism, and such as ought to suggest a sympathy and fraternity of feeling. If bravery is a quality of excellence in those who call themselves the "fighting men," when have medical men, either in or out of the army, shown themselves cowards?

During the terrible epidemic of yellow fever at Norfolk, Va., in 1852, 40 physicians, most of whom had volunteered their services from neighboring cities, died of the pestilence.

* New York Journal of Medicine, vol. 15, 2d series, p. 424, from Medical Times and Gazette.

During the same year 14 house-surgeons of Bellevue Hospital contracted typhus, and 7 died; and in the year which has just passed, 16 have fallen sick with the same malady, and 8 have died. Yet their places have never remained vacant.

Napoleon always called his medical officers "my brave surgeons;" and we believe that no class is less amenable to the charge of cowardice than medical men generally. They are trained in a Spartan school, under, if we may so term it, a law of ethics which allows no man to turn his back upon danger. Whatever may be the peril, they are expected to go wherever their services are needed. They make no great ado about it; nor are their names often mentioned in the official reports; and still less often are they breveted for soldierlike conduct; yet they go, wherever they are called, quietly about their business, alone or in small detachments, in rain and in snow, by night and by day, on the march and on the bivouac, through watchfulness, and fasting, and fatigue, into the midst of malaria, contagion, and battle. Indeed, the men who can remain cool and self-possessed in the midst of deadly contagions, ought to stand well the fire of musketry. Can any one suppose that the forty physicians who never turned their backs, but fell with their faces towards the enemy at Norfolk, or any one of those thousands—our compatriots in arms—who have fallen on other fields, have died any less heroically than Warren on Bunker's Hill? Or that they would have marched any less steadily upon the batteries at Fredericksburg than did the brave men under Burnside and Hooker? We think they were all brave men alike, and alike entitled to public gratitude.

We challenge any man to-day to point us to an educated physician who has fled at the approach of pestilence, or

who has hesitated to enter the trenches, or to face the batteries, if required to do so in the performance of his legitimate duties. Even when the strict letter of his instructions forbade his exposure, the medical officer has seldom been backward to accept any duty which the exigency seemed to impose upon him.

In this way fell, at the terrible slaughter of El Molino del Rey, on the 8th of Sept., 1847, the author's beloved pupil, George Wm. Roberts, Assistant-Surgeon in the 5th Regt. U. S. Infantry. Having received from the Staff Surgeon no authority to retire (an omission which, in the confusion of the onset, may be readily explained), he continued at the head of his regiment until nearly all the officers had fallen, when he begged permission from Capt., now Major-Gen. Charles Hamilton, who was at that moment disabled by a wound in the shoulder, to be allowed to lead the broken column. Permission was granted, there being no officer of the line left to succeed in the command; and in a moment after Roberts received a wound through his head which proved fatal; but his death did not occur until several days after the battle, and when he had received at the hands of his comrades all the attention and care which their affection for him could suggest.

During the present war a large number of medical officers have died or been discharged from the service, invalided, on account of diseases contracted in the performance of their duties in hospitals and upon the field. It has been their custom, whenever the condition of their sick or wounded soldiers seemed to render it necessary, to give themselves into the hands of the enemy; and of those who have thus given themselves up, some have been subjected to tedious confinement in prisons,* some have died from

* Among those who have been for longer or shorter periods confined in prison by the Confederate Government, are the names of Dr. Slocum, U.S.N.;

almost absolute starvation,* and many have returned completely broken down in health. Nor are there wanting examples in which our surgeons have been wounded and killed upon the battle-field while in the performance of their appropriate duties.†

It is with pleasure that we refer those who deny the medical officers such courtesies as a law of Congress has

Dr. Hoffman; C. A. Thatcher, of Greenbriar, Va.; W. Thompson, Green Co., Ky.; David Patterson, of Romney, N. H.; all of whom were, on the 26th of July, 1862, in prison at Salisbury, N. C. George Marvine, Act. Assist. Surg., U.S.N., detained as a hostage.

* Act. Assist. Surgeon J. L. Sutton died in the hands of the enemy at Savage Station, Va., on the 25th of July, 1862, of fever, rendered more fatal by the want of proper food; and on the following day Act. Assist. Surgeon Wm. H. Milnor died from the same cause.

Surgeon Guy C. Marshall, of the Berdan Sharpshooters, captured on the Chickahominy, contracted typhoid fever and died in New York, July 25th, 1862, soon after his release.

† Surgeon John W. Brennan, 1st U. S. Sharpshooters, received a wound at the battle of Gettysburg, on account of which he has been discharged from the service.

Surgeon A. C. Williams, 2d U. S. Sharpshooters, has also been discharged on account of wounds received at the battle of Chancellorsville.

Surgeon Nathan M. Bemis was severely wounded in the leg at Pittsburg Landing.

Surgeon Havens, of the 15th Mass., and Assist. Surgeon Lewis, of the 2d N. Y. Mil., were both wounded at Fredericksburg by fragments of shells.

D. W. Hand, Surgeon of Volunteers, was severely wounded in the back at the battle of Fair Oaks.

Surgeon Fergusson received a ball in his leg at Bull Run; and Assist. Surgeon Weed, of the 17th N. Y.V., was wounded by a ball which passed through the popliteal space, at Hanover C. H., May 27th, 1862.

Surgeon Hartman, of the 107th Ohio Vols., 11th Corps, was shot through the abdomen at the battle of Chancellorsville, and subsequently died of his wounds.

Surgeon — White, U.S.A., Medical Director of the 6th Corps, was shot through the head at South Mountain, Md., Aug. 14th, 1862, and killed instantly.

instructed the officers of the line to observe, to the views of one who is in no way connected with the medical profession, and whose opinions, from the position of isolation and independence which he occupies, will be entitled to respect. Lord Dalhousie, in a memoir upon the Medical Service, appended to the report of the Parliamentary Committee, remarks as follows:

"There are several particulars in which the Medical Service, as a body, lies under great disadvantages, and which they regard, justly in my opinion, as grievances that ought to be removed. I refer to the inequality which now prevails between the position of a medical officer and that of his brother officers, in respect of pension, honor, and rank. I respectfully submit that such inequalities are founded on no sound grounds of justice, expediency, or policy; no valid reason ever has been, or can be, alleged for maintaining them. Their effect is to depress the spirit of the medical officers, to depreciate a profession and class of service which ought to be held in the utmost respect, and supported equally from motives of prudence and gratitude.

"But the most galling, the most unmeaning, and purposeless regulations by which a sense of inferiority is imposed upon medical officers, is by the refusal to them of *substantive rank*. The surgeon and assistant-surgeon rank invariably with captain and lieutenant, but the rank is only *nominal;* whenever medical officers and others are brought together on public duty, the former have no rank at all, and the oldest surgeon on the list must, in such case, range himself below the youngest ensign last posted to a corps.

"It is impossible to conceive how such a system as this can have been maintained so long on the strength of no better argument than that it has been, and therefore ought to be! It is impossible to imagine what serious justification can be offered for a system which, in respect to external position, postpones service to inexperience, cunning to ignorance, age to youth; a system which gives a subaltern who is hardly free from his drill, precedence over his elder, who perhaps has served through every campaign for thirty years; a system which treats a member of a learned profession, a man of ability, skill, and experience, as inferior in position to a cornet of cavalry, just

entering on his study of the pass and audit regulations; a system, in fine, which thrusts down grey-headed veterans below beardless boys."

So late as the year 1829, Mr. Berrien, then Attorney-General of the United States, in reply to an inquiry—"Whether chaplains, surgeons, or pursers, who are regarded on board our ships as non-combatants, are competent to officiate as members of a naval court-martial?" declared that they were not; which decision he rested mainly on the fact, that a tribunal descended from the ancient Court of Chivalry could be composed of none other than military men. The Attorney-General denied at that time that surgeons had rank, either real or assimilated.

We will not discuss the doctrine thus officially announced, farther than to remind our readers that it implies a disposition to engraft feudalism upon modern civilization.

The following General Order, issued by Mr. Toucey, Secretary of the Navy, not quite three years since, will show that, upon this point, a change of opinion has occurred in that Department:

"General Order, Navy Department,
March 2d, 1861.

"Whenever any officer of the Corps of surgeons, paymasters, or engineers, is arraigned for trial before a Court of Inquiry or Court-Martial, the Court shall consist in part of officers of the corps to which the accused belongs."

Can the Secretary of War show any good reason why a similar rule should not have been applied to the Army? If it had been done, our present able Surgeon-General would have had at least one officer of the Medical Department sitting with the Court which is now investigating the charges which have been preferred against him.

Until the commencement of the present war the rank of the Surgeon-General, chief of the medical bureau, was that of Colonel; the Assistant Surgeon-General holding the rank of Lieut-Colonel. With these two exceptions, no medical officer had rank higher than that of Major.

By an Act of Congress passed two years ago, the Surgeon-General was made Brigadier-General, and the Assistant Surgeon-General was made Colonel; and at the same time the office of Medical Inspector-General was created, with the rank of Colonel, and sixteen Medical Inspectors with the rank of Lieutenant-Colonel. No other medical officers—neither Medical Directors of Departments, chiefs of corps, divisions, or brigades, rank above a Major.

By Act of Congress in 1862, commissaries, quartermasters, etc., serving on the staffs of corps commanders, were made Lieutenant-Colonels, while the rank of Medical Directors serving upon the same staffs was not changed!

In the medical staff there is no such thing as promotion for good conduct or for the performance of signal services. Even the barren honor of *brevet* is usually denied to them. Although brevets have often been recommended in official reports during the present war, upon medical officers, in no instance has any notice been taken of the recommendation.

What test of respectability, of social, moral, or intellectual standing, has the government adopted upon which these and many other invidious distinctions are made? We venture to say that officers of the same rank in other departments are no more respectable than the medical officers of the U. S. Army. If they were so, we should hold those responsible for the differences who deny to surgeons equal rights, equal pay, and equal honors. The surgeons of the regular army have all been subjected before admission to an examination as rigid as that which is required

for admission to any of the armies of Europe; and their reputation for learning is notorious, and has been the subject of observation and of admiration the world over among medical men. A defence of these gentlemen would be out of place, when there is no one to dispute their position.

As to the volunteer surgeons, it might be sufficient to say that, with few exceptions, they are the only commissioned officers of the volunteer army who have had any previous education or training to the peculiar and respective duties which they have been called upon to perform. With very few exceptions, they are graduates of medical colleges, many of them having completed their education in large hospitals. A very large proportion of the "surgeons of volunteers" and surgeons of regiments, have been themselves in charge of civil hospitals, or they have been engaged, before entering the service, in practice, and there is nothing in the experience of a camp, except the mere routine of business, with which they are not perfectly familiar. Among all the surgeons of the army, you will not probably find one who was, up to the moment of his entrance upon the performance of his duties, a merchant, a lawyer, a tailor, a shoemaker, a grocer, a saloon-keeper, or anything else, either more or less, than a physician or surgeon. Moreover, nearly all volunteer surgeons have been subjected to examinations by regularly constituted State medical boards before their commissions have been given to them. In no case which has come to our knowledge has this examination been omitted. While it is well known that at first, and for many months after the war began, no officer of the volunteer service, not in the medical corps, was, in a single instance, subjected to an examination of any kind, nor, in general, were any testimo-

nials required as to intellectual or moral qualifications. Nor is there at the present moment any such examination or testimony uniformly demanded. Officers of the line are liable to an examination by a board appointed for that purpose, upon the complaint of their commanding officers that they have been found incompetent. And this is all. Medical officers are liable to similar examinations before similar army boards.

The presumption is, therefore, established in our favor, and we are happy to be able to verify this presumption by an intimate personal acquaintance with a large number of the volunteer surgeons.

The only remaining point to which we wish to call attention at this time is the amount of *authority* vested in the medical officers of the army, with a view to a consideration of the question whether it is sufficient for the purposes intended; and we may say at once, that it is the almost unanimous opinion of the army surgeons that it is not sufficient unless the medical officers have complete control of the medical department, in the same manner and to the same extent, that the officers of the corps of engineers control their department. In this opinion the writer fully concurs.

The objections to conferring authority upon medical officers are the same which have been urged against medical rank; and in addition to these it has been claimed, that to divide or distribute authority is to destroy the unity and power of the army, and that it is essentially destructive of all military discipline. The first of these objections has already been sufficiently considered, and the second is very well disposed of by Dr. Tripler in a few words: "The dogma of the necessary alternate of commanding or being commanded, that has been the fruitful source of so many

mischiefs, and is at the root of the difficulty of securing the efficient coöperation of the different professions that are now combined in the organization of the army, has had its practical refutation demonstrated in our service by the experience of almost half a century. The law forbids the exercise of command, out of their corps, to the officers of the engineers. Still they are not subject to the orders of their juniors in the line. They cannot command, nor are they commanded except by a superior; and what has been the result of this assumed military heresy? Let the world produce their superiors as an efficient and scientific corps! Their independence of all outside interference, and their being exclusively intrusted with the means of performing their own duties, have made them what they are, and the country has reaped the advantages of its wise legislation in regard to them. This is the only corps in the army that has any analogy with the medical as regards scientific acquirement, specialty of function, peculiarity of administration, and claims to independence of action, because it is not at all understood or comprehended by any other department."*

We conclude, then, that to the medical officers ought to be intrusted the complete control of the medical department, because upon the preservation of the health of the troops depends, in a great measure, the success of every expedition; because no others than medical men are, by their education and habits, qualified to perform this duty; because no one else is competent to decide upon the proper location of a hospital, its construction, ventilation, or general arrangement; no one else can determine what is necessary for the sick in the way of diet, clothing, medicines,

* Amer. Med. Gazette. Introduc. Lec. on Mil. Surg. By Charles S. Tripler, M.D., Surgeon U.S.A. (1848.)

etc.; no one else knows when rooms are overcrowded and are in danger of becoming pestilential, or when patients can be removed with safety. In short, because officers of the executive department, from the entirely distinct nature of their pursuits, whatever they may believe to the contrary, do actually know as little of hygiene, medicine, and surgery, as they do of engineering. Because, moreover, medical men are supposed to be qualified, they are appointed for the express purpose; and because, without authority, they are unable to carry out their own views, and it is impossible, therefore, that the public service can receive the full benefit of their ability.

Fortunately, recent events in the Crimea and in Turkey have furnished an opportunity to test, in some degree, the relative value of the two systems as applied directly to the medical department.

The French army sanitary system is exceedingly complicated, and its details are made out in the most elaborate manner; nothing is left to conjecture; every duty is defined so explicitly that there can be no chance of error. As to authority to deviate from these rules, they have none. Each hospital is placed under the charge of an officer of the line, called the Military Intendant, whose only qualification for this position is that he possesses military rank by virtue of which he is entitled to command. The medical officer merely prescribes and makes surgical operations, dresses wounds, and *suggests*. He cannot command the most subordinate attaché of the wards. He cannot, in theory, order a nurse to dispense a medicine, or a sick soldier to leave his bed, except through the Military Intendant.

In the British service the system is much less elaborate, and there is much less precision in the rules which govern its details. So that, to the casual observer, it seems imper-

fect, and contrasts unfavorably with the French system; but the British surgeons are permitted to exercise a certain amount of authority over their own department, such as is not allowed to the French surgeons.

In the Allied expedition against Russia, of 1856, the British medical officer had authority to command over the hospital orderlies, the nurses, and the apothecaries. He was permitted to regulate the general hospital police, to give orders, and to enforce their execution in relation to the hygiene, medication, and subsistence of the sick.

The result, fairly traceable to these apparently insignificant, but as every medical man knows them to be, important practical differences, was that the English army closed its campaign with a loss, by death or invaliding, of less than one-third of the troops, while the French had lost more than one-half of their whole number.

It must be understood also that by far the largest proportion of those who died or were invalided in these campaigns were thus lost to the service by epidemics, such as the cholera, dysentery, etc., which were in a great measure capable of prevention. The proportion lost by wounds received in battle was very small, probably not more than one in ten or fifteen.

Whether, as more than one writer has intimated, the French were compelled to make a hasty peace, because their forces were broken and disheartened by the progress of disease amongst them, we are not prepared to say; but however this may be, it is certainly capable of mathematical demonstration that without large additional conscriptions, and we may add, some change in the condition of the sanitary police of the army, the Emperor would have been compelled soon to close the war on the part of France by a disgraceful retreat.

M. Baudens does not hesitate to declare the imperfection of the French regulations as contrasted with those of their English ally, and to intimate the real source of their own misfortunes. "The English hospitals," he remarks, "were remarkable for cleanliness. We have seen that this quality did not exist in ours. The difference is partly due to the higher and more independent military position which the English surgeon holds, and which entitles and enables him to exercise greater authority in hygienic measures. His ordinary sick-diet table is more ample and varied than the French, and the surgeon can order what extras he thinks proper for the sick. Indeed, the English camp was abundantly supplied with stores and comforts of all kinds; to which circumstance is to be ascribed its preservation from scurvy and typhus in 1856."

To the crowding of sick tents and huts into a confined area, in opposition to the protests of the army surgeons, both in the Crimea and at Constantinople, this writer ascribes the persistence of the cholera, and the prevalence and ravages of typhus and hospital gangrene. The army intendants and the medical officers entertained wholly different opinions as to what constituted overcrowding. The intendence functionaries "adhered to the strict letter of the military rule: so long as the patient had the regulation allowance of cubic feet, overcrowding was an impossibility; while physicians saw it to exist from the moment when disease was aggravated, and its fatality augmented by reason of too many sick being congregated within a given space."

What can be more conclusive? Admitting that some minor embarrassments might arise from an occasional collision of authority between coördinate branches; still is it not too plain to allow of a doubt, that to subordinate a

department, with which are intrusted such vast interests, to a department wholly unacquainted with its duties, is to put the whole army in extreme peril, and to place the results of the expedition almost upon the hazards of a die?

The position which we assume, however, is that, so far as experience goes, there is no evidence that by rendering certain departments of the army coördinate the danger of collision is increased. On the contrary, we believe that by this method alone can collision be effectually prevented. They will have less contact, either personal, ceremonial, or official; consequently, we believe, there will be less jarring, less jealousy, less crimination, and more faithful service.

In the American service the amount of authority vested in a medical officer is very much the same as in the British service. The medical officer in charge of a hospital has authority to command over all of his subordinates, including surgeons, stewards, apothecaries, ward-masters, orderlies, nurses, matrons, and guards. The entire management of the internal affairs relating to police, commissary supplies, medicines, etc., etc., are under his control, except when, as very seldom happens, a military governor, corresponding to an *Intendente*, is placed in immediate command. In our experience this has happened but once, and then its inconveniences were soon observed, and the officer of the line was promptly relieved.

It might seem, therefore, that our medical officers had very little reason to complain of the want of sufficient authority; but there is one point in relation to which, with all respect for the opinions of the officers of the line, we think the authority of the medical officer is manifestly insufficient. The surgeon in command of a general hospital may enforce obedience upon the soldiers so long as they are

permitted to remain under his charge; but he is not allowed to detain a soldier, whatever may be his condition, against the order of his superior officer of the line. A recent decision of a court-martial has settled this question definitively; one of the most valuable and highly accomplished medical officers of the U. S. Army, having been sentenced to several months' confinement at his post for refusing to permit a wounded soldier, upon whom a severe surgical operation had been made a few days before, and who still remained in a critical condition, to be removed under an order for his arrest, until the order had received the approval of the Surgeon-General or of his immediate representative, the Medical Director of the Department.

We are at a loss to conceive the propriety of the rule as decided by the court to which we have referred; nor do we think that any one can seriously claim for it either necessity, justice, or humanity.

CHAPTER II.

EXAMINATION OF RECRUITS.

THE examination of recruits constitutes an important part of the duties of a military surgeon. Upon him depends the selection of the men who are to constitute the rank and file of the army. It is as necessary that the choice should be made judiciously as that the army should be supplied with proper weapons and suitable food. Writers upon military surgery have, therefore, given to this subject a good deal of attention, and nearly all governments have adopted regulations for the guidance of recruiting officers and boards of inspectors, differing somewhat according to the peculiar service in which the men are to be employed, the kind of weapons used, the length of time during which they are to serve, the genius of the people, and the exigencies under which the enlistments are made.

We shall endeavor to give, in this chapter, a general idea of what is required of those who enter the "regular army" of the United States of America by voluntary enlistment or by draft.

Age.—The candidate must not be younger than eighteen years, nor older than thirty-five; and if under twenty-one, he must furnish evidence that he is about to enter the service by consent of his "parent, guardian, or master."

No man having a wife or child can be enlisted *in time of peace* without special authority obtained from the Adjutant-General's Office through the Superintendent; this rule not being applicable, however, to soldiers who "re-enlist."

If, however, the applicant has been in the army before,

he may be received although he is over thirty-five years. If he re-enlists before two months have expired, he receives two dollars and fifty cents extra pay per month, the extra pay dating back two months. If he intends to enter the ranks as a musician, he may be younger than eighteen years.

It is the general opinion of army surgeons that eighteen years is too young. The various organs of the body are not at this period of life completely developed, and such persons are often incapable of that endurance which is so necessary to a complete soldier. It is also often impossible to foresee what will be the character of the constitution when the growth and development are completed. Sir George Ballingall says: "Upon a full consideration of all the circumstances, I think we may state that the most eligible period of life for enlistment is from twenty to twenty-five years of age;" and perhaps it would serve the interests of the government equally well if young men were never admitted until they were fully of age, since the department would thus be saved the heavy expense incident to the enrolment of minors whose parents or guardians subsequently obtain their release.

In the present war most of the boys who were under eighteen, and many of those under twenty, had to be discharged within the first three or four months.

The opinion of that great general, Napoleon, of the relative value of boys and men as soldiers, may be inferred from his communication to the Senate, after the battle of Leipsic; and when some of its members had shown a reluctance to accede to his demands. "Shame on you," said the Emperor, "I demand a levy of 300,000 men. But I must have grown men; boys serve only to encumber the hospitals and roadsides."

As pertinent to this subject it may be remarked, also, that in the naval service, where enlistments are made at a very early period of life, examples of extreme longevity are much more rare than in the army.

Height.—The regulations relating to height have varied in different countries and in different periods, and seem to have been made generally with reference to the exigencies of the service. At present the minimum for the British regular service is five feet five and a half inches, and in the Anglo-Indian army it is five feet six inches. Formerly the British regulations demanded five feet six and a half for the infantry, and five feet seven for the cavalry. In the French army the present minimum is five feet one inch and nearly one-half, but men are not unfrequently enlisted who are only five feet one inch.

In our service the standard has been frequently changed. By an Act of Congress in 1790 it was fixed at five feet six inches; but in 1796 this law was repealed, and the matter left subject to the regulations of the Army Board. During the war with Mexico, the regulations demanded only five feet three inches; but by the regulations of 1854 it was fixed at five feet four and a half inches; in 1861 it was again reduced to five feet three inches, and such is the requirement at the present time.

The experience afforded by the Crimean war, where the English soldiers labored side by side, in the trenches, upon marches, and in the assault, prove conclusively that the additional stature of the English troops gave them no advantage over the French. Now that battles are no longer decided so much by weight of arm as by strategy, promptness of action, rapidity of movement and precision of aim—length of limb and even power of muscle are not so essential. What is needed now in the soldier is activity

and endurance, and these are by no means the peculiar attributes of size or even of simple muscular strength. A man of short stature will frequently endure a long and forced march better than a tall man; and we have seen professed pugilists who would lose their breath, and be placed completely *hors de combat*, by a rapid walk up a moderate acclivity.

Weight.—We do not think any man ought to be accepted who weighs over 200 or 220 lbs., and who is at the same time below six feet in height; we have been compelled during the present war to recommend for discharge several men on the sole ground of obesity; nor, on the other hand, ought the candidate to be received if he is too slight or puny, with a weight of less than 100 lbs. Perhaps on an average, it may be stated, that the best soldiers are composed of men who weigh from 135 to 150 lbs.

Striking Deformity.—The soldier ought to have something like proportion and harmony in the different portions of his body; not so much for the reason that he will present a more soldier-like appearance, and is likely to have more self-respect, but because marked deviations from the usual law of nature generally imply physical infirmity.

A head large or small, out of proportion to the body; arms or legs either too long or too short; very crooked legs, a deformed chest, or any other deformity sufficiently unusual to excite attention and remark, indicate in general the early existence of some constitutional malady which, although it may have ceased to progress, great exposure or fatigue may awaken into a fatal activity.

Intemperance.—Habitual intemperance is a sufficient ground for rejection, not only because the soldier will be tempted on every possible opportunity to drink, but especially because the constitution of such a man is in all proba-

bility seriously impaired, if not irretrievably ruined. "Moreover," says Dr. Tripler, "first in a mutiny and last in a battle, the intemperate soldier is, at once, an example of insubordination, and a nuisance to his comrades."

It is a positive rule of the service not to accept of a man who is at the time of the examination intoxicated; but if he repeats his application when he is sober, or if he only shows signs of a recent debauch, it will then be necessary to ascertain whether his intoxication was accidental, or whether he is habitually an intemperate drinker. The man who has been accidentally betrayed into intoxication may look pale, his eyes may be heavy and somewhat reddened; but the habitual drunkard has, in most cases, his face and nose studded with pimples, his lids are red and thickened, his eyes are blood-shot and watery, his hands tremble, his tongue refuses to articulate distinctly, his breath has a peculiar odor, and the whole muscular system is frequently in a condition of atrophy. Especially is this the case with the muscles of the lower extremities.

Moral Character.—It is necessary also to the preservation of discipline, that the recruit should not be a bad man, or a thorough villain. Convicted felons, men who have suffered imprisonment in jails or state prisons for criminal offences, deserters, and professional fighters, are not proper men to be received. They are troublesome, refractory, and soon poison the minds of others.

In our experience the best soldiers have generally been the sons of farmers, who, with a good English education, unite, generally, a certain moral training.

Having made these preliminary inquiries and examinations, we are now prepared to enter into a more minute investigation of the applicant's condition. For this purpose, he ought to be washed and stripped, and we should

commence the examination at the head, in order that we may proceed systematically and overlook nothing.

Baldness, when not excessive, cannot be regarded as a disqualifying circumstance, but when a large portion of the scalp is exposed in a person under thirty-five years of age, it may lead to a suspicion that the subject is laboring under secondary or tertiary syphilis, or that he is suffering from some other grave constitutional malady; and besides, the soldier who is bald finds it inconvenient to keep upon his head the military cap, and when uncovered he is peculiarly exposed to the intense heat of the sun in summer, and to the cold of winter.

Chronic eruptive affections of the scalp, of whatever character, if extensive, ought to be regarded as disqualifying conditions. Their cure is likely to prove troublesome; they exact on the part of the man himself greater care and time for cleanliness, and it is not certain but that they may be conveyed to others.

A very large or very small head, as we have already intimated, implies imperfect development or hypertrophy, neither of which is consistent with a perfect constitution.

Tumors of the Scalp.—One, or even two or three small encysted tumors upon the scalp could scarcely be regarded as of sufficient importance to demand a rejection, unless they happened to be situated just where the cap would press upon and inflame them. They are not likely to become sources of trouble unless an attempt is made to remove them. Tumors of almost any other kind, even fatty tumors, as they are apt to attain a great size, are causes for rejection.

Old wounds of the scalp ought to invite an inquiry into the cause, and especially with a view to ascertain whether the skull has been broken, or any cerebral symptoms followed

the accident. We have known cases in which, after severe blows upon the scalp, although, so far as could be ascertained, no fracture had taken place, epilepsy has, after the lapse of many years, supervened.

We ought certainly to reject every applicant whose skull has been actually broken at any period of life. If the fracture was limited in extent and no fragments were ever removed, even though the depression was very slight, our own experience shows that epilepsy is very likely to supervene at some period of life; and if the fracture was extensive, and fragments of bone have been removed, the subject is still liable to cephalic pains and congestions from any unusual exertion, and he is wholly unfit for the duties of a soldier.

Defects in hearing, when permanent and incurable, render the applicant unfit for admission to the ranks, since he is liable to misunderstand the orders. If, however, it is temporary, depending upon a cold which has swollen the tonsils or the mucous membrane of the mouth, and produced an occlusion of the eustachian tubes, or when it depends solely upon wax or some foreign body in the ear, the applicant may be admitted whenever the cure is accomplished, or even before if the surgeon feels quite certain as to the cause of the deafness.

Obliteration of the auditory canal, chronic eczema of the canal, a discharge of matter, malformation, or loss of a portion of the external ear, generally disqualify.

Sight.—We may first examine the condition of the lids, brows, and of the lachrymal apparatus, since it is no more important that the sight should be perfect, than that the means of preservation should be complete.

A total absence of the eyebrows, equally with baldness of the head, implies, generally, the existence of a cachexy,

or constitutional vice; moreover, the eye has lost in consequence one of its most important means of protection. The eyebrows are black and long in the natives of tropical climates, and all persons have more or less the power of corrugating and lowering the brow, in order to exclude the too intense and direct rays of light from the sun. They serve, also, by their peculiar arrangement, the supercilia being imbricated and inclined downwards and outwards, to direct the perspiration upon the temples, and thus to protect the eye from those acrid salts which accompany this secretion.

Absence of eyelashes, also, is generally accompanied with chronic tarsal ophthalmia, or with trichiasis, and is a sufficient ground for rejection.

Chronic tarsal ophthalmia, being either, in general, a mark of intemperance or of a scrofulous diathesis, is a disqualifying circumstance. The upper and lower lids ought to be everted and examined carefully, and the position of the cilia upon the margins of the lids should be noted.

Eversion or inversion of the lids disqualifies.

Ptosis, whether congenital, from paralysis, or as a result of chronic inflammation, is a cause for rejection.

The existence of small encysted tumors, which are very common upon the upper lid, and seldom attain a greater size than a pea, need not constitute an objection.

Obstructions of the lachrymal ducts, at whatever point, or from whatever cause, are liable to recur or continue; and since such obstructions occasion great annoyance, and even at length lead to sensible impairment of vision, they ought to be regarded as causes for rejection.

A pterygium, unless it is very small and not progressive, ought to occasion rejection. Its tendency to encroach more and more upon the cornea until it reaches the centre, is

very great; nor is it always a very curable affection, even when subjected to the knife.

Strabismus, in either eye, or in any direction, ought to be a cause for rejection. The strabismic eye is, in a great majority of cases, myopic, and such persons are very apt to see objects double.

In the "Manual" the conclusion is reached that strabismus of the right eye disqualifies for any service; but if it is only in the left eye, the subject is not disqualified for infantry or artillery service, but only for cavalry. In this opinion we can scarcely agree with the author of the "Manual," or with the author of the "Aide-Memoire," to whom reference is made as sustaining this view.

The fact is, that strabismics are, in general, not so vigorous as others; their vision is occasionally double, the vision of one eye being usually myopic; the strabismic eye wearies under long use, and is more prone to inflame.

Since the commencement of the rebellion we have seen a good many examples of strabismus in the army, most of the subjects of which soon found themselves disqualified, and of their own will made application for a discharge.

In an examination of about fifty applicants for discharges, on the ground of physical disability, in the 32d Regt., N. Y. St. V., we found two examples of strabismus externus. Among the applicants, also, was a man with one glass eye. He had been previously inspected, but the fact of his wearing a glass eye had not been discovered.

Ulcerations of the cornea, hernia iridis, staphyloma, are sufficient causes for rejection.

Opacity of the cornea, if the result of recent inflammation, however limited in extent, is a sufficient cause for rejection; since it is not certain but that it will increase,

and the inflammation having only recently disappeared, it is very liable to return.

If the opacity is ancient and not extensive, and does not interfere with correct vision, it may not be a sufficient cause for rejection.

Irregularity of the pupil, such as to affect vision; adhesion of the pupil, are causes for rejection.

Cataract, glaucoma, amaurosis, whether in one or both eyes, we need scarcely say, demand rejection; so also, hydrophthalmia, exophthalmia, and vascillitans bulbi.

Myopia, if considerable, is a sufficient cause for rejection.

Presbyopia is not a cause for rejection unless it is very decided.

Loss of the nose usually implies, in this country, the prior existence of a syphilitic taint. But from whatever cause it may be wanting, the disfigurement is such as to render the subject liable to cruel jests, and to be an object of disgust to his companions.

Obstructions of the nose, such as to impede free respiration through the nasal passages, whether from polypi, ozœna, morbid thickening of the mucous membrane, or from any other cause whatever, provided always these causes are known to be chronic or incurable, are disqualifying conditions.

Hare-lip, or any striking deformity of the mouth, from burns, wounds, or disease, disqualifies.

The loss of many teeth or a general decay of the teeth indicates in most cases a general physical infirmity. Good teeth are needed not only for the mastication of tough salt meat and "hard tack," but also for biting off the cartridge. A toothless soldier is about as worthless as a toothless watchdog.

Disease or mutilation of the tongue is a disqualification. So also is stammering, if it exists in any considerable degree.

Chronic enlargement of the tonsils is generally a sign of a scrofulous diathesis.

A large goitre, interfering with respiration, or such as prevents the wearing a stock comfortably; enlargement of the submaxillary, sublingual, or parotid glands, or of several of the absorbent glands of the neck; the existence of old cicatrices, occasioned by suppuration of these glands, ought to be considered as disqualifying circumstances.

Malformation of the chest, sufficient to embarrass respiration.—If the chest of the candidate is narrow in its transverse diameter and exceedingly prominent in front, and especially if, at the same time, the shoulder blades stand off remarkably from the body, and are imperfectly covered with muscles, it is not probable that he will endure long marches well, or fatigue duty of any kind.

These men may give no positive sign of lesions of the lungs, and yet all experience shows that they are more than others predisposed to tubercular and other affections of the thoracic viscera.

A flattening of one side of the chest from chronic pleurisy; organic and even serious functional diseases of the heart, forbid the acceptance of a recruit.

Asthma is usually spasmodic, occurring only at intervals, and it is possible, therefore, for an applicant to impose upon the recruiting officer, by presenting himself when the paroxysm is off. But if it has existed long, it is probable that such permanent lesions of the heart and respiratory organs will be present as will determine the fact of unsoundness independently of the asthma.

Enlargement of the abdominal viscera, whether of the

liver, spleen, or of any other organ; ascites or tympanitis, are disqualifying diseases.

The fact that the person is very subject to diarrhœa or to dysentery, or even to violent attacks of colic, is sometimes a ground for rejection.

Complete absence of the penis, epispadias, hypospadias, at or beyond the middle of the penis; stricture of the penis, a perineal fistula, incontinence of urine, as causing inconvenience in urination; castration, complete atrophy or great hypertrophy of the testicles, indicating some constitutional malady, or rendering the person liable to suffer from slight causes in these organs; all enlargements of the testicles, or of the seminal ducts, or distensions of the tunica vaginalis; the existence of chronic eczema in these parts, should be deemed causes for rejection.

If the testicles have never descended, or by having descended they are occasionally retracted partly or entirely within the abdomen, the subject is more liable to a hernia.

Varicocele.—Dr. Tripler says, that "out of 5,000 rejections in our service, 877 were for varicose veins and varicocele." He properly adds: "If men are to be rejected for this affection indiscriminately, our rendezvous might almost as well be closed."

The truth is, that a moderate varicocele seldom is anything more than a source of inconvenience, and one which the wearing of an ordinary suspensory bandage will usually relieve. It is not, therefore, without some qualifications, a ground for rejection.

Prolapsus ani, stricture of the rectum, fistula in ano, we need not say, are positive disqualifications. We would ourselves say the same of hæmorrhoids, whether external or internal, so long as they remain uncured.

In the British Regulations, hæmorrhoids are said to dis-

qualify "when they exist to such a degree as will immediately, or in all probability may at no distant period, impair a man's efficiency." But it is not always easy to determine by their present appearance, when hæmorrhoids are to become troublesome; it having often happened to us to see cases of simple external piles, uninflamed, which occasioned no inconvenience until the man has mounted a horse, or has had an attack of diarrhœa or of constipation, and which then have at once become very serious affairs. In our opinion it would be a better rule in all cases of small external hæmorrhoids to direct the applicant to submit to a very simple operation for their cure, namely, excision, and to return to the rendezvous when the cure is completed; rejecting, peremptorily, all applicants suffering with internal piles, and all with large external piles.

The existence of any form or degree of abdominal hernia ought to be regarded as sufficient cause for rejection.

It is a question, however, whether large abdominal rings can be regarded as conditions predisposing to hernia. It will be observed that the external abdominal ring varies greatly in size in different persons who never have had a hernia. We have noticed this, both in the dissecting-room and in the examination of living persons.

Not long since we were consulted by a young man who said he had been rejected as an applicant for the office of policeman in the city of New York, on the ground that the external rings were large. We found them sufficiently large to admit freely the forefinger, and we could carry this finger up to the internal ring. There was no hernia in the canal, and the internal ring was close and firm. This man had been a sailor during the last seven or eight years, doing duty before the mast. He was a strong, mus

cular man, and we cannot think he was likely to have a hernia. Indeed, it is not so much the condition of the external ring as of the internal which disposes to rupture.

If, however, the person has an oblong swelling in the situation of the canal, it is probable that an internal hernia already exists, and it may be a sufficient cause for rejection.

In examining the recruit to ascertain the existence of a rupture, the finger should be introduced into the external ring. This is best done by placing the point of the finger at first low down upon the scrotum and carrying it up, as it were, through the scrotum by invagination. By this method the finger enters easily the inguinal canal, while if it is applied directly from over the ring, it is always more difficult to feel and often impossible to enter the ring. The subject must be then directed to cough while the finger of the surgeon is in this position, and while the hands of the subject are extended and clasped over the head. Non-descent of the testicle, as strongly predisposing to hernia, is a sufficient ground for rejection.

Spinal distortions, of whatever character, if seen to be the result of disease, such as rachitis in early life, or of caries (Pott's disease), or of muscular weakness, indicated by a lateral curvature, ought to cause rejection. Even persons who are exceedingly round-shouldered are not usually proper subjects for active military service. They are not likely to have the same thoracic capacity, and they are, especially when loaded with their knapsack, very unsoldierly men for a line.

We must next proceed to examine the condition of the extremities, and for this purpose the man will be instructed to walk, run, jump, hop, kneel, extend and flex his arms, etc., etc. It is the opinion of Jackson, that "a full-grown

person who is not capable of marching at the rate of four miles in the hour, with firelock and knapsack, is not eligible for a soldier destined for the field service. If his wind fail in walking briskly up hill, or his joints be weak, so that he does not move with speed and safety over broken grounds, it would be unwise to enrol him on the lists of an active army." He therefore thinks that it would "be proper that every person who enters the army should be brought to trial in walking, running, leaping, climbing hills, and traversing irregularly broken grounds." Dr. Tripler, who approves of this rigid course of inspection, especially since the introduction into our service of the severe drill of the *chasseur-à-pied*, nevertheless thinks that in the places where these inspections are generally made, such tests of capacity are impossible.

The custom of recruiting officers in this country is to exercise and display the points of the recruit somewhat in the following manner:

He is first walked around the room on a rapid gait; next he is directed to run; then to hop a short distance, first on one leg and then on the other. He is now halted and set up in the position of a soldier under arms, with the knees about one inch apart, and while in this position he is examined again in front and in rear. He is then directed to extend his arms at a right angle with his body, touch the shoulder with the fingers, place the backs of his hands together above his head, flex and extend his arms, rotate the forearm, flex and extend the wrist, each finger and thumb.

The recruit should be directed to stand first upon one foot and then upon the other, moving the ankle-joint while standing upon the floor; he should kneel, first upon one knee and then upon the other, and subsequently upon

both, being made to rise each time without touching his hands upon the floor. The surgeon ought to examine carefully with his hand every part of the upper and lower extremities.

A fracture of the clavicle anywhere through the middle third, united with a manifest overlapping, disqualifies, not by diminishing the strength of the limb, but by rendering it inconvenient to wear the knapsack strap. If, however, the fracture has been at any other point, and it is united, it ought not to disqualify.

A dislocation, or partial dislocation, of the clavicle at either end, if unreduced, usually impairs the strength of the arm, especially in holding a weight at a right angle with the body, or in lifting a weight above the shoulders.

Fractures of the shaft of the humerus, even though badly united, do not, after a year or two, generally maim the arm; but if they are in the vicinity of the joints, they often produce more or less anchylosis, and of course, in such a case, disqualify. After a dislocation, also, either of the shoulder or elbow, there may exist either anchylosis or atrophy, but it is by no means constant.

Fractures of the radius and ulna do not necessarily maim, even if badly united, yet they are more likely to do so than fractures of the humerus.

Fractures of fingers, and of other bones of the hand, often leave no maiming.

A dislocated finger, however, is very liable to be followed by some anchylosis.

We ought to ascertain that there are no ganglions about the wrist.

Webbed fingers, split fingers, loss of either phalanx of the thumb or forefinger of the right hand, loss of two or more phalanges of either finger of the right hand, loss of

either thumb, loss of any two fingers of either hand, mutilation of all the last phalanges of either hand, complete anchylosis of any finger, but especially of the forefinger of the right hand, are absolute disqualifications.

Fractures of the neck of the femur always cause lameness.

Fractures of the shaft, in adults, usually unite with overlapping, but unless this is sufficient to make the subject limp, it ought not to disqualify.

Fractures of the patella probably always render the person less able to endure long marches. So also all fractures involving the knee-joint.

Dislocations at either end of the femur may cause stiffness, but if reduced, especially in the case of the hip-joint, no lameness may follow.

Fractures of the leg, also, in general cause lameness or weakness, but not so generally as in case of the femur, unless the fracture be at the lower end, involving the joint, or it be accompanied with a dislocation.

We think a complete luxation of the ankle, or a fracture of any of the bones of the tarsus, always produces some weakness in the foot.

The surgeon should carefully examine and compare the two knees. If swollen, or enlarged, or very much bent in, so as to render the man "knock-kneed," he should be rejected. The existence of a bursa at this point should also cause his rejection.

Varicose veins, if considerable, or if attended with œdema, or ulcerations, or dark spots, are causes for rejection.

Ulcerations demanding rejections are those combined with great loss of substance; with atrophy of the limb; with general constitutional disorder, or with varicose veins.

Club-feet positively disqualify.

Splay-feet, or those in which the natural arches are almost completely lost, do not necessarily disqualify. It is very common to find this form of foot among the laboring people, especially upon the continent of Europe. Many of these men may, after a little, become very good soldiers, but in not a few examples which have come under our notice the result has been otherwise. Such men cannot always be relied upon for long marches.

Valgus absolutely disqualifies. In these cases the arches are not only lost, but the muscles, whose tendons pass behind the malleolus internus, being preternaturally weak, and the internal lateral ligaments being elongated, the ankle-joint falls inwards, as the knees do in cases of knock-knee, so that the inner border of the os naviculare actually touches the ground. Such persons generally turn the toes very much out, and walk with the inner side of the foot presenting forwards.

Loss of the great toe; loss of any two toes of the same foot; webbed toes; double toes; the great toe crossing the second very much, so as to render the metatarso-phalangeal articulation very prominent; much overriding of all the toes; permanent retraction of the last phalanx, so that the free border of the nail touches the ground; ingrowing and ulceration of the nails, are all actual disqualifications.

At Gallatin, Tenn., we saw a soldier whose feet were so large that the Quartermaster could not furnish him with shoes. He was walking with his bare feet, and had been in this condition eight months. His number was thirteen, while the Government supplies no shoes larger than eleven. Very large feet may therefore sometimes be a just ground for rejection.

Epilepsy, if it has occurred within five years; chorea; paralysis of any member; scrofula; constitutional syphilis, disqualify for the military service.

The "Manual" would not consider the primitive accidents of syphilis as an insuperable ground for rejection; but we cannot agree with the author in this opinion.

Itch, and chronic incurable diseases of the skin, of a constitutional or specific character, etc., are disqualifying maladies.

General feebleness of constitution, with constitutions like women; brands for desertion or for drunkenness, disqualify.

CHAPTER III.

GENERAL HYGIENE OF TROOPS.

SECTION I.—DIET. The food supplied to soldiers, whether in the field or in barracks, ought to be wholesome and abundant. We scarcely need to say that we do not demand for the army a luxurious diet; but only that those who serve their country faithfully, should, whenever it is possible, have enough food to satisfy all reasonable wants; and that, however coarse and plain it may be, it should be nutritious.

In reference to a luxurious mode of living, whether we consider it in its relations to the soldiers or to the officers, no one entertains a doubt as to its pernicious effects. It has proved the destruction of many fine armies which were invincible to all other enemies.

Great military chieftains, who have led their armies to conquest, have been nearly always men of frugal habits and unaccustomed to a sumptuous fare. Says Jackson: "It is reported that General Wolfe, who was perhaps the most perfect soldier of the age in which he lived, never gave an elegant, and rarely an eatable dinner to persons of the *haut gout.* General Wolfe's table was said to be an epitome of a Spartan mess-room—no one rose from it without having been furnished with the opportunity of carrying away a military lesson; and few left it without feeling an accession of military importance communicated to the mind by the impressive influence of a hero's spirit."

As to the particular articles of diet, no special rules can

be established, since these must depend upon the season of the year, the nature of the country through which the troops are to pass, the character of the diseases to which they will be most exposed, and upon the ability of the commissary to meet the demands made upon him.

In general it is impossible to keep troops constantly supplied with fresh meat and fresh vegetables, especially when they are upon long marches; yet it is always desirable, at least in this country, that they should have both in a certain proportion. Where this is impracticable, the army must be furnished with salted or dried meats, dried vegetables and fruit, sourkrout, and with hard bread, as the next best alternatives.

The salted meats are generally either beef or pork. The desiccated meats, vegetables, and fruits, are now prepared at home, as well as in France and in other foreign countries. These, especially the mixed vegetables, have been supplied to the United States Army in great abundance during the present war, and of excellent quality. Among the vegetables found in the mixed varieties, are potatoes, onions, cabbage, tomatoes, carrots, turnips, string-beans, green peas, and asparagus. During the early part of the war our soldiers were very reluctant to use them, their first attempts in cooking being almost uniformly unsuccessful. It is necessary, in order to obtain the flavor of the vegetables and to render them tender, that they should be soaked in cold water at least one hour; and six, or even twelve hours, is better before cooking. This is not always practicable, especially when the troops are on a march, and for this reason the desiccated vegetables and meats cannot always be used.

When we consider the compactness—dried and compressed, as they are, under heavy hydraulic pressure—the

lightness, the imperishable nature of these articles, we must understand their value as army supplies at all seasons of the year; but it is especially when troops are sent into the north-western territories, and beyond the reach of winter supplies, that they are furnished usually with quantities of desiccated vegetables and fruits, as an important means of protection against scurvy. Portable soup—we refer to that form so called which is desiccated and sold in the form of thin cakes—is even more condensed than the desiccated vegetables, and possesses the great advantage that it can be prepared for use in a moment, or as soon as water can be made hot. A pint of hot water poured upon a cake one inch square and one quarter of an inch thick, with a little salt and pepper, which latter a good soldier always has in his haversack, makes a tolerably full and not unpalatable meal. This form of portable soup has not been furnished to the army, so far as we are aware; yet we think it is much better than the "canned" soup, which is very liable to become spoiled before it is used, however carefully it may be put up. The canned soup has, nevertheless, very often proved of great value when distributed immediately after a battle; and the supplies furnished to the hospitals, both by the Government and the Sanitary Commission, have contributed much to the recovery and comfort of the sick and wounded soldiers.

Concentrated milk is an excellent substitute for fresh milk, but it has never been furnished to the army except in small quantities and only for hospital purposes. Solidified milk is much inferior, yet it will prove very acceptable when the former cannot be obtained.

In the winter of 1861–2, extract of coffee was furnished to the troops, near Alexandria, at Fairfax C. H., and at other places; and in nearly all cases where it was used it

was said to produce nausea and vomiting, and was soon thrown aside. It is quite probable that the coffee was adulterated; and the recent example of a government contractor having been sentenced to a protracted imprisonment for having practised such adulterations, confirms this suspicion. The ground coffee, also, issued by the commissary, has seldom been found to be of a good quality. It is better, therefore, as a general rule, when troops are permanently encamped, to issue raw coffee in the seed and provide utensils for burning and grinding it.

Bread is with all civilized nations an important article of diet, and it is especially so in grain-growing countries like our own. It is necessary, therefore, that the supplies of this article should be ample in quantity and suitable in quality. Dr. Mann, in his "Medical Sketches," enumerates, among the active causes which led to the production of disease among the troops along the Niagara frontier during the campaign of 1812, "bad bread." "It was notorious," he remarks, "that the bread on the Niagara was made of damaged flour; such as was either not nutritious, or absolutely deleterious. It was believed, also, that the flour contained, in some instances, an earthy substance, and that this adulterating substance was "plaster of Paris."

No such complaints have been made during the present war; the bread, whenever furnished, being, with few exceptions, of excellent quality. During a great portion of the time, however, only hard bread—"hard tack"—has been supplied to the troops. But it is certain that, if possible, troops should be supplied with fresh bread, and to this end the government ought to establish in the vicinity of permanent encampments, bakeries. When this is impracticable, division, brigade, or regimental commanders may perhaps construct bakeries upon the field; as was done in the com-

mands of Gens. Kearney, Blenker, and others, during the winter of 1861–2, while the Army of the Potomac was encamped near Alexandria. The troops will then be enabled to procure always a supply of fresh bread; and to a division, the sum saved and distributed in money to the command has sometimes in a few months amounted to several thousand dollars.

In relation to alcoholic liquors as a part of the rations for soldiers, Dr. Mann, whose opinions, from their eminently practical nature, we are happy always to quote, speaks as follows: "My opinion long has been, that ardent spirits are an unnecessary part of the ration. This allowance, as a part of a ration, is not, however, the evil which demands a remedy. It is the abuse of spirits. Sutlers, unrestrained as they frequently are, destroy more lives by these liquors than are lost by other causes to which soldiers are exposed; and, so long as ardent spirits are permitted to be publicly sold in the vicinity of a cantonment, these evils cannot be remedied by any restrictions under which sutlers may be placed. A soldier habitually intemperate, is always industrious to procure the means of indulging his appetite. All his cunning and every artifice are put into requisition to obtain the inebriating draught. Reputation, honor, health, and even life, are sacrificed to this gratification."

Examples may be furnished to demonstrate that ardent spirits are a useless part of a soldier's ration. At those periods, during the revolutionary war, when the army received no pay for their services, and possessed not the means to procure spirits, it was healthy. The 4th Massachusetts regiment, at that eventful period of which I was the surgeon, lost in three years, by sickness, not more than five or six men. It was at a time when the army was des-

titute of money. During the winter of '79–'80, there was only one occurrence of fever in the regiment, and that was a pneumonia of a mild form. It was observable in the last war, from December, 1814, to April, 1815, the soldiers at Plattsburgh were not attacked with fevers as they had been the preceding winters. The troops, during this period, were not paid; a fortunate circumstance to the army, arising from a want of funds. This embarrassment, which was considered a national calamity, proved a blessing to the soldier. When he is found poor in money, it is always the case that he abounds in health. A fact worth recording!"

It is now several years since, mainly through the recommendations of Gen. Cass, while Secretary of War, the whiskey rations were stopped in the United States Army, and rations of coffee and sugar substituted. Sutlers are expressly forbidden to keep it among their stores; yet it is found impossible, except when stationed out of the reach of civilization, to prevent the soldiers from obtaining it occasionally, or some equally pernicious substitute.

By special orders No. 152, issued from Head-Quarters of the Army of the Potomac, May 19th, 1862, it was declared that "upon the recommendation of the Medical Director, an extra ration of one gill of whiskey daily, will be issued until further orders to every officer and soldier in this army; half to be served out in the morning and half in the evening. The Subsistence Department will provide the whiskey on proper requisitions."

This order was issued at a time when the troops had for several weeks been subjected to great hardships in long and fatiguing marches, in labor upon the trenches, in severe battles, in skirmishes and picket duty, in exposure to rains and malaria, and sickness was prevailing to an alarming extent. The men were weary and exhausted by incessant

labor and watchfulness. To the intelligent Medical Director of the Army of the Potomac, it seemed that now, if ever, these extra rations of whiskey might prove serviceable; especially as the army was encamped along the banks and amid the swamps of the Chickahominy, notoriously one of the most malarious regions in Virginia.

By most of the army it was accepted as a boon, and by no commanding officer, so far as we are informed, was it refused.

On the 19th of June, just one month from the day on which the order above mentioned was issued, the following notice appeared in General Orders:

"HEAD-QUARTERS, ARMY OF THE POTOMAC,
CAMP LINCOLN, VA., June 19th, 1862.

"Gen. Orders No. 136. The extra issue of whiskey, heretofore ordered, will be immediately discontinued. All commanding officers are enjoined strictly to enforce existing orders directing that hot coffee be served to the troops immediately after reveille.

"By command of Major Gen. McClellan," etc.

The reasons which influenced the Commanding General in making this last order, we have no exact means of knowing; except that it is certain there was no lack of whiskey in the Commissary Department, and its withdrawal as a ration could therefore only imply that it was not thought to be useful to the soldiers.

Our own experience during the period named was, that drunkenness had become much more common, and the troops were in no better condition of health. Indeed, many cases which have come under our observation showed conclusively that, so far as diarrhœa and dysentery were concerned, and these were the diseases at that time especially prevalent, the whiskey ration had proved a source of mischief instead of relief. Affections of the bowels were

generally increased in severity and frequency by its use, while we never saw an example in which it had effected a cure. Surgeon T. R. Spencer, Medical Director of Gen. Smith's Division, in his official report to the writer, then Acting Medical Director of Gen. Franklin's Corps, expressed the opinion broadly, that the whiskey had increased bowel affections, and that it was nothing but an unmitigated source of evil.

On the 29th of May the writer was ordered to report to General Keyes, and was on the same day made Medical Director of his Corps. Here our observations confirmed our convictions derived from what we had seen in Gen. Franklin's Corps, namely, that the whiskey ration was an evil; but some days before we had been assigned to duty in the 4th Corps, the Senior Surgeon of one Division, Dr. Prince, Brigade Surgeon, had expressed his views upon this subject to the Medical Director of the Army, in a communication which subsequently passed through our hands, and which we fully endorsed. Surgeon Prince stated in this communication, that, so far as the opinions of the Medical Officers of the Division were known to him, they were adverse to the whiskey ration, and he stated his own objections as follows:

"The ration is given without discrimination between those who need it and those who do not.

"The army ration of food, though faulty in kind, is more than sufficiently nutritious for men who have good digestion, and especially so for men who are lying idle in camp. From the nature of the case, the men will be most likely to get the whiskey ration when idle in camp; while, upon the march, when it might be claimed to be useful to the more feeble portion of the men, they will not have it; and at the end of a forced march the supply will be very certain not to be at hand.

"From principles of health and endurance, well enough appreciated

when applied to horses, it is known that over-stimulation in periods of inactivity is unfavorable to the greatest activity and endurance in periods immediately subsequent. If this is true, it must be obvious that the whiskey ration, as it must be given under this order, must be most mischievous to the health and endurance of the army, over-stimulating the men when they are inactive, and failing to be at hand when exhaustion from fatigue might make it useful.

"It is believed," says Surgeon Prince, "that whiskey has no power of preventing or curing disease arising from residence near marshy ground, except as it counteracts exhaustion from fatigue; and if so, the whiskey ration, from its indiscriminate use while inactive, favoring subsequent fatigue, which it will not be at hand to relieve, fails of any useful end, and is on the contrary, in the main, hurtful.

"While all considerations of future health and usefulness in the soldier must be made subsidiary to his immediate military efficiency, it must be unfortunate to institute unnecessarily a *routine* of stimulation which makes the soldier a victim to the habit through life."

At the same time that these issues were being made by the Commissaries direct to the soldiers, the Medical Purveyor was forbidden to furnish alcoholic stimulants upon requisitions made by surgeons, and even the supplies which had been promised to Division Surgeons were for some reason not furnished. The consequence was—yet we presume this result was not intended—that surgeons were deprived of any voice or agency whatever in its administration.

Subsequently, on the 21st of June, at a meeting of the Medical Officers of the 4th Corps, held pursuant to an order from Head-Quarters, to deliberate upon the causes, character, and treatment of the diseases then prevalent in the Army of the Potomac, it was declared to be the "unanimous opinion of the meeting that the indiscriminate use of the whiskey ration was injurious."

It is earnestly desired that no such experiment will ever

be repeated in the armies of the United States. In our own mind the conviction is established by the experience and observation of a life, that the regular routine employment of alcoholic stimulants by men in health is never, under any circumstances, useful. We make no exceptions in favor of cold, or heat, or rain, nor indeed in favor of old drinkers, when we consider them as soldiers. Men who have been hard drinkers, when first enrolled, and deprived wholly of their stimulants, sometimes become exhausted and die, or have to be discharged: but such examples are rare; while on the other hand, most of these men soon improve in their general condition of health, and not a few are permanently cured of their habits of intemperance. If, however, the soldier who was formerly a habitual drunkard, obtains a single glass of liquor, his appetite often returns with new vigor; and we have known instances in which the return of the appetite has created a desire and longing so intense as to render the men for a time wholly valueless as soldiers.

Assistant Surgeon Bartholomew, in his report to the Surgeon-General, March, 1859, speaking of the condition of the troops stationed at Fort Bridger, Utah Territory, remarks: "A vile concoction, known as whiskey, has been from time to time surreptitiously sold to the troops, notwithstanding prohibitory orders from the commanding officer. Manufactured by traders from alcohol, tobacco, and other narcotics, this liquor has in one instance produced an immediately fatal effect, and more or less alarming symptoms in various instances." In Mexico many of our soldiers were made sick, and not a few died, in consequence of having drunk the pulque, a stimulating drink obtained from the Agave Americana, a species of cactus which grows abundantly in that country.

Wellington had his rations invariably delivered to the

soldiers daily, unless the circumstances were such as to render this impossible, for the reason that he found that men would eat up or waste in a single day what was intended for two or three, trusting to chance, to forays, or to opportunities for purchase, to supply themselves until the rations were distributed again.

We think it necessary that soldiers should have three meals per day; especially is this deemed necessary for soldiers who are American citizens, and who have become accustomed to the habits of our own people in this respect. These meals may consist in general of a light breakfast of bread and coffee, taken always before the morning parade or the march; a substantial dinner of meat and vegetables at midday; and a pretty substantial supper at the close of the day.

One of the first things soldiers need to learn is how to cook. The art of cookery is as important to the soldier as the art of defence; and especially as the one is in requisition daily, while the other is in demand only at long intervals.

When troops are permanently encamped, the cooking should be done by company cooks, regularly detailed for that purpose; but on long marches, especially when the conveniences for cooking in large quantities are not at hand, by dividing the men into squads of three or five, and by detailing alternately one of the men to prepare the meals according to an established order of fatigue, a sort of emulation will be encouraged, while each will learn, from observing the ingenious expedients of the other, and very soon they will all acquire a tolerable degree of excellence.

Salted meats should be well soaked before they are cooked, and soups should be made from the meats by the addition of such vegetables and condiments as may be at

hand in the commissary's stores, or as can be obtained in the adjacent fields. "C'est la soupe qui fait le soldat." The meat may be afterwards placed in the haversack, and eaten cold at the next meal or on the march, if needed; but whether meats are boiled or roasted, it is a fundamental rule to boil slowly and roast quickly.

Sudden changes, even from a bad to a better diet, have not unfrequently proved disastrous to troops.

During the Mexican war, most of the men who were brought down to Vera Cruz from the Rio Grande had to march over the country by the way of Tampico, having only salted meat, and that chiefly pork, with hard bread and beans. Those who went in transports fared no better. Soon after leaving Vera Cruz, however, the soldiers fell in with large droves of cattle, which they slaughtered, and eat of the fresh meat freely. In consequence of this, diarrhœa and dysentery began to prevail, and before they reached Cerro Gordo the army was already in a bad condition from this cause. At Jalapa, where great numbers of the sick and wounded were crowded into a cold stone church, a great many died. Perote also proved equally fatal to the troops, although it was accounted one of the most healthy situations in Mexico. The soldiers died not only of dysentery in great numbers, but, in consequence of the prevalence of bowel affections, nearly all the wounded did badly. The wounds did not generally become gangrenous, but they refused to heal, and the patients sank from the continued and exhausting suppuration.

During the present war, in the matters of food, the great evil has been a want of variety, and especially an insufficiency of fresh vegetables. Our government has never withheld the money when it was needed for the comfort of the soldier on the field; and, in a most liberal manner, the

amount and variety of the rations have been authorized to be increased.

The daily rations for the soldier in the American army at the present moment, and authorized during the continuance of the rebellion, are as follows:

Pork or bacon, twelve ounces, or as their equivalents, salt or fresh beef, twenty ounces; twenty-two ounces of bread or of flour, or twenty ounces of corn meal, or one pound of hard bread. To every one hundred men there may be issued also, daily, ten pounds of green coffee, or eight pounds of roasted and ground coffee, or one and a half pounds of tea; fifteen pounds of sugar; eight quarts of beans or peas; ten pounds of rice or hominy; four quarts of vinegar, and two quarts of salt. There is allowed also, in addition to the above, to every hundred men, one gallon of molasses, and, three times per week, one pound of fresh potatoes to each man, provided, of course, they can be obtained. When beans, peas, rice, hominy, or potatoes, cannot be supplied in the quantities or proportions allowed by regulations, an equivalent in value is allowed of any other proper vegetable food; as, for example, desiccated potatoes one ounce to each man, or mixed desiccated vegetables one ounce to each man. In case also it is thought proper, and when the supply on hand will permit, these desiccated vegetables may be issued instead of beans or peas, or instead of rice and hominy. Fresh beef may be issued daily instead of salted meats, if a sufficient supply can be obtained and the health of the troops demands it. Moreover, at the discretion of the commanding officer, onions, cabbages, beets, carrots, and various other vegetables may be occasionally added to the rations.

It need scarcely be said, after this enumeration, that no government ever provided more liberally for the wants of

its soldiers in respect to food. It is nevertheless true that our soldiers have not always been well fed, even when campaigning in those portions of the country which have abounded with vegetables, grain, and animals suitable for food.

It has not been the general policy of the War Department to subsist the troops upon the enemy, and only in rare instances has foraging been allowed or practised; never, perhaps, except when the exigencies of the case rendered it absolutely necessary; and then only to a limited extent, and under special restrictions, the officer in charge of the foraging party being instructed to leave an amount sufficient for the necessities of the owner, and to give a receipt for what he has taken. Individual instances of indiscriminate pillage no doubt have occurred, but such conduct has seldom received the countenance of commanding officers, and never of the general Government.

Another reason which no doubt may be properly given why the soldiers have not always had a sufficient variety of food, and especially of fresh vegetables, is, that the company and regimental officers of the volunteers have not understood the necessity, nor indeed the manner of securing company funds, and the privates have therefore seldom had it in their power, except by using their own money, to render themselves independent of the commissary.

We are convinced, however, that the principal reasons why the troops have not had fresh vegetables in greater abundance are, that the commissaries and commanding officers have either not known the true condition of matters, or they have been ignorant of what would be the consequences.

Whatever explanation we may adopt, the fact remains, that owing to an insufficiency of vegetable food the armies

of the United States have been, a large portion of the time, in a condition of imperfect health, and often scorbutic.

Thus, for example, when the army of the Potomac, under Major-Gen. McClellan, was lying in front of Richmond, on the Chickahominy, early in June and soon after the battle of Fair Oaks, scurvy began to manifest itself, and continued to increase until August, when we left the Peninsula. For a period of five or six months probably not one full ration of fresh vegetables had been issued to the troops. In the latter part of August, a few days before we left Harrison's Landing on the James river, vegetables were supplied in abundance; but they came too late to put the army in condition to make another advance upon Richmond. When the order was given to leave the Peninsula, we were directed to send to the transports all the men of the 4th Corps who would not be able to march at the rate of three miles an hour without their knapsacks; and under this order my surgeons turned over to me something more than 2,000 men. In about the same ratio, also, all the other Corps were depleted. Most of these men, we believe, were in some degree scorbutic. It is our confident belief that 20,000 men might have been saved to Gen. McClellan's army during this unfortunate campaign, if the men had been furnished at all times with a reasonable amount of fresh vegetables.

When, on the first day of April, 1863, we visited the Army of the Cumberland, commanded by Major-General Rosecrans, and composed then of 70,000 or 80,000 men, we found scurvy to a limited extent in almost every regiment, the men not having had more than one, or at most two or three, regular issues of fresh vegetables in eight, ten, or twelve months. In a few regiments where, under the good management of the officers, company funds had been accu-

mulated, and especially where the men had been required to cook by companies, the men had been able to supply themselves with vegetables in small quantities from time to time; and, with the additional advantage of better cooking, they had escaped scurvy. It is worthy of remark, also, that the number of well marked cases in the German regiments was greater generally than in other regiments which had been no better supplied by the commissaries; a fact which we could only explain by supposing that their well known habits of economy restrained them from using their own money, even for the purchase of such extra articles of diet as other soldiers occasionally bought. Whatever may have been the explanation, the fact is attested by the reports of several surgeons and by our own observation.

To those who are not familiar with the numerous and complicated duties which devolve upon officers commanding large armies, it may seem a matter of surprise that such facts as we have stated do not come to their knowledge, and that the remedies are not promptly applied; but the truth is, that whatever information they possess must be obtained from subordinate officers, and, with the exception of the medical officers, there are very few of these subordinate officers who understand what are the usual results of abstinence from vegetable food; officers in the immediate command of regiments or of companies, often, when the inquiry is directly made, acknowledge their want of supplies; but they have seldom evinced much interest in the matter. So long as men are not dying in considerable numbers directly from scurvy, they manifest no alarm; for they have never been made to understand that, to some extent, all men must be scorbutic who have been excluded such a length of time from vegetables; that the rheumatic pains, the bloody discharges from the bowels, the tender gums, the short breath,

irregular action of the heart, the obstinate ophthalmiæ, the sudden deaths of patients suffering under diarrhœa, the speedy exhaustion of men in the trenches and on the march, were all the results of impoverished blood; that the frequency, rapidity, and fatality of typhoid pneumonia were due in a great measure to the same cause; that men who were slightly scorbutic often presented an appearance of robust health, especially when their bloated features were bronzed by exposure to the sun and air. Even the surgeons are not always fully awake to the danger which is upon them when *one* well marked case of scorbutus is brought to their notice. It is not often we find more than five or ten striking examples of scurvy in one regiment at a time; but if there is but one, it ought to furnish a substantial ground of suspicion that the physical condition of the whole, or nearly the whole, of the command is impaired.

In the Army of the Cumberland the surgeons, however, had been long reporting, from week to week, the pressing necessity for vegetables; but we could not learn that any one of these reports had ever been seen or read by the commanding officers; and when it became our duty to call the attention of Corps Commanders, and even of the Commander-in-Chief of this army to the facts, with few exceptions, they confessed their entire ignorance of the true state of affairs. More than this, the commissaries of brigades, of divisions, and of corps, as well as the Commissary-General of the army, who themselves received and distributed the supplies, fully believed that the soldiers had plenty of vegetables; and that when they had not received more than three full rations in twelve months. The explanation of this extraordinary fact is, that during nearly all this time fresh potatoes, and occasionally other vegetables, were received and issued; but of one hundred barrels issued by

the Chief Commissary, at least twenty-five went to the staff officers' families and servants at Head-Quarters, and to the Post, including often citizens and hospitals; of the seventy-five remaining for distribution to the Corps Commissaries, twenty-five more barrels disappeared again with the officers and their families; a third distribution to the Division Commissaries blotted out another twenty-five barrels, and a fourth to the Brigade Commissaries disposed of the remainder in a like manner, so that the Regimental Commissary received none—and it is here that the inquiry must always be made, or with the soldier himself, if an inspector desires to know how the troops are fed.

When it is remembered that a large portion of these vegetables is usually spoiled *in transitu* to the army, and that many more decay before the final distribution, it will be easy to understand how one hundred barrels, shown as received and distributed daily on the Chief Commissary's books, are completely sifted out before they reach the men in the field. In confirmation of this statement, we will quote a portion of our report for the month of May, 1863, made to the Commanding General of the Department of the Cumberland. It will be noticed that, up to the first of April, the soldiers had not, on an average, received from the Government over three rations in twelve months, and that from this date Gen. Rosecrans and his Commissary had determined that the troops should be abundantly supplied. To this end, extraordinary efforts and attention were now directed to the matter. We will see with what result:

"In my previous report I informed you, sir, that from the 1st of April the Commissary-General had been receiving at the rate of 100 barrels of fresh potatoes per day, but that on the 9th of April, almost none of these had reached the regiments. On the 20th of May, I ascertained that this department had received from the

Government at the rate, on the average, of 150 barrels per day, from the first day of April up to that moment, which, at a fair computation, would give one full ration of potatoes to every soldier in the command, on every alternate day.

"The fact of the arrival of these vegetables at this rate was, I found, generally understood by the commanding officers, and Major-General McCook, commanding the 20th Corps, informed me that his mind had been completely set at rest upon this subject, by the report of his own inspector (not a medical officer), that the supply was now sufficient. I was able to furnish him, however, with the written statement of four regimental commissaries in his Corps, and these were all of whom I had made inquiry, that only one full ration of potatoes had been received by the men in April, and but three in May."

The soldiers belonging to the other two corps of the army had been no more fortunate, and we were obliged, for the third time, to call the attention of the Commander-in-Chief to the fact, and to suggest, as the only remedy, that hereafter the private soldiers should receive the first distribution, and that officers, citizens, etc., should then be permitted to take what remained. We sought, also, to impress upon the Commanding General the importance of early attention to this matter, by reminding him that, in case of a great battle, the wounds would not heal kindly—that pyæmia, erysipelas, and hospital gangrene would destroy the lives of thousands who might otherwise be saved.

"The lessons of the past," we took the liberty of saying to the General, "are always forgotten; and every year and every campaign repeats the errors of the last. When, on the 21st of July, 1861, the first battle of Bull Run was fought, the troops had been but a short time upon the field, and had not suffered from the prolonged absence of vegetable food. The consequence was, that nearly all of the wounds healed kindly; hospital gangrene was unknown at Alexandria or Washington, and erysipelas and pyæmia were rare occur-

rences. I visited all of the hospitals in and about Washington, after the battle, and make these statements from my own observation.

"Such were not the results, however, after the battle of Williamsburg, Fair Oaks, the seven days' battle, when we crossed the Peninsula; the second battle of Bull Run, Antietam, Fredericksburg, and Murfreesboro. Indeed, from the date of the first battle of Bull Run to this moment, wounds have been followed with results and accidents more and more serious; and that, too, notwithstanding surgeons are becoming more skilful in the performance of their duties, ambulance and hospital arrangements are more complete, and the Sanitary Commission, with its overflowing supplies, is more promptly at hand.

"The cause of this increased fatality is to be found, I think, sir, mainly in the impoverished condition of the blood of the soldiers, and yet it is not understood by the officers or men; or, if it is understood, no one seems to act as if it was. The men are still deprived of vegetables."

In still further confirmation of the correctness of our views, we will mention that in many of the regiments stationed in Kentucky and Tennessee during the summer of 1863, all slight wounds, such as scratches, slight burns, etc., took on an ulcerative action and often became ugly and intractable sores. Vaccination almost constantly produced the same results, and was in very many cases followed by abscesses in the axillary, cervical, and other glands.

Upon the evacuation of Murfreesboro by the Confederate army, on the 1st of January, 1863, 1673 sick and wounded soldiers were left in our hands; of these, 250 were sick, and 1423 were wounded. The whole number were placed in charge of Dr. Avent, the intelligent Medical Director of Gen. Bragg's army, assisted by several other Confederate surgeons, and were allowed to remain in the buildings which they had originally taken as hospitals, and which were the best the place afforded.

On the 20th of May, 1863, nearly five months after the battle of Stone's River (Murfreesboro), Dr. Avent reported to us that 640 of these men had died, and 55 remained in the hospital, the remainder having been sent off for exchange. "The ratio of deaths," continues Dr. Avent, "allowing the same percentage for the 55 now on hand, is about 38¼ per cent. I have not separated the sick in this calculation from the wounded, from the fact that the hospitals were common to both; consequently I have no positive data on which to make an estimate of the relative mortality. I am satisfied, however, that the mortality amongst the sick has been much less than of the wounded. An estimate, placing the percentage of the wounded at about 40, I think would not be far wrong; which loss, you will discover, is unprecedented in any previous battle between the present belligerents."

In explanation of this great mortality after wounds, Dr. Avent proceeds to offer several facts; namely, overcrowding of the patients in the hospital buildings, mental depression, the fact that only the most severely wounded were left behind; but he gives especial prominence to the physical condition of the men, in consequence of a prolonged absence in their food of anti-scorbutic articles, both before and since their capture.

We ought to mention that, during the periods when the Army of the Cumberland was in need of fresh vegetables, the U. S. Sanitary Commission was constantly supplying the General Hospitals on the field, the Post Hospitals, the Convalescent Camps, and, to some extent, the Regimental Hospitals, with potatoes, onions, and other vegetables; and when, in the early part of April, 1863, we notified Dr. Read, the chief of the Sanitary Commission of that department, of the urgent need that fresh vegetables should be supplied

to the troops themselves who were in the field, the Commission responded with a promptness and liberality which were most gratifying, and which demonstrated the value and importance of their organization. It was understood that the army was preparing to advance, and an important battle was anticipated; under these circumstances, there could be no delay, if the troops were to be put into a healthy condition before the action occurred. The Sanitary Commission was notified of our wants on the 11th of April. On the 13th we were informed by Dr. Newberry, the energetic Secretary of the Western Department, that there would be "immediately forwarded large shipments of vegetables for Gen. Rosecrans's army by railroad and by boat, the superintendent of the road having been requested by the Commander-in-Chief to forward promptly all that the Commission can send." On the 16th, 130 barrels arrived at Murfreesboro; and from this time, for several weeks, they continued to arrive at the rate of about 100 barrels per day, and were distributed directly to the troops by the agents employed by the Commission. It is worthy of notice, also, that while those sent by the Government were often damaged by decay in consequence of the barrels having not been properly opened for ventilation before being shipped, and from delay or lack of care in the shipment; those sent by the Commission were always ventilated by an opening of about two inches in diameter in the sides or ends of the barrels before being shipped, and they were almost uniformly in good condition. At one time the Medical Director, Surgeon Perin, found at Murfreesboro 1500 barrels lying in the Commissary storerooms; not one barrel of which, we believe, had any ventilation, and the contents of most of which, when we came to open them, were more or less decayed. They were

waiting an order from the Commanding General to issue them, but the Commissary had failed to notify the General that they were on hand. The Medical Director, Dr. Perin, promptly informed the General, and an order was at once obtained for their issue.

Such facts as these do not always indicate inefficiency, perhaps, on the part of the Government officers, but rather that the multiplicity of their duties renders it difficult, if not impossible sometimes, to give the necessary attention to all the minor details.

The result of the more free introduction of fresh vegetables into the Army of the Cumberland was, that very soon the cases of scurvy were found to diminish in frequency and in severity; and when, on the twenty-fourth of June, the troops were moved forwards and an engagement with the enemy occurred, the wounds received by the soldiers healed more kindly and were followed by fewer accidents than had been the case after previous battles.

Owing to the admirable strategy of General Rosecrans, a victory was achieved with only a small number of casualties upon our side, the number of killed and wounded probably not exceeding 500; but while the Commanding General was able to congratulate himself and his soldiers upon the fact that he had obtained most important results with a comparatively small loss, the medical officers of the army were permitted also to enjoy the reflection that, in consequence of their own forethought and timely attention, a very large proportion of those who were wounded recovered, and in due time were again returned to duty.

At the same time that an effort was made to secure for the soldiers a better supply of vegetable food, at the suggestion of Surgeon Perin, the intelligent Medical Director

of the Army of the Cumberland, the troops were instructed how to prepare their food, and especially were they informed as to the best mode of making soups. On the tenth of April, by General Orders No. 76, it was directed that hereafter the cooking should be done by companies, instead of by squads, and that soups should be served to the men at least four times a week; namely, beef-soup twice a week, and bean or pea-soup twice a week. The manner of making the soups was as follows :—

BEEF-SOUP FOR FIFTY MEN.

Fresh beef, cut into pieces of four or five pounds each,	lbs.	35
Desiccated vegetables,	"	3
Rice,	"	4
Flour, sugar, and salt, each	"	2
Pepper,	oz.	1
Water,	galls.	8

The orders were to soak the desiccated vegetables from reveille until after breakfast; and immediately after breakfast to put all the ingredients into kettles at once, except the flour; set them over the fire, and when the boiling had commenced, to diminish the heat and allow the soup to simmer gently until eleven o'clock; then add the flour, previously mixed with enough water to form a thin batter, and boil one hour longer.

In order to make good beef-soup the ingredients ought to be put into cold water and the heat gradually applied; since, if the heat is intense at first, the exterior of the meat becomes hardened at once, and the juices do not escape; the meat also will be tough and unpalatable. The soup should be stirred occasionally to prevent its burning or sticking to the sides of the vessel. The de-

siccated vegetables should also be well separated before being put to soak.

BEAN-SOUP FOR FIFTY MEN.

Beans,	qts. 4
Bacon or pork,	lbs. 15
Onions,	no. 3
Pepper,	oz. ¼
Water,	galls. 8

For cooking the above the following excellent instructions were given:—

Soak the beans over night; at reveille in the morning put them into vessels carefully cleaned, and boil steadily until done; then mash them with a spoon or masher made for the purpose, and strain through a colander if practicable.

Immediately after breakfast put the bacon or pork, cut in pieces of from three to five pounds, into another kettle with water and boil for an hour; pour off the water, add the bacon to the soup, with onions chopped fine, and pepper, and boil until noon. Remove the bacon and cut it into smaller pieces suitable for serving with the soup.

In the preparation of this soup, soft or rain water should be used where practicable, as water containing lime does not soften the bean as quickly; and if, in consequence of the evaporation, water has to be added, it should be hot and not cold water. The reason for directing that the vessel should be clean, and that the bacon should be added after the beans are done, is, that grease hardens them.

It may be well to know that some beans soften much more quickly than others, and that, where they continue

to resist the action of the water, the addition of a little pearl-ash or soda will soften them speedily.

When peas are issued instead of beans, they should be treated in the same manner.

Commanding officers were charged to see that these orders were strictly enforced; and the officers of the Inspector-General's Department were ordered to report semi-monthly, and the inspecting officers of the Medical Department were ordered to report weekly every instance of neglect, with the name of the officer who was responsible for the delinquency.

We mention this order especially and in detail, because of its intrinsic value, and also because it illustrates the care which Major-General Rosecrans took of his soldiers; and because it is a part of that complete and thorough discipline which contributed to make the "Army of the Cumberland" the most perfect in its police, discipline, and finally in the condition of its health, of any army we have ever seen upon the field. To these causes, no less than to the confidence which the troops always felt in their Commanding General, may be traced its extraordinary achievements and successes.

Section II.—Cleanliness and Camp Police. The health of troops has always an intimate and direct relation to their habits and personal cleanliness and to the sanitary police of their camps.

None understand this so well as medical men; since the influence of koino-miasms, the origination of disease from impurities of the atmosphere and their propagation through the same media, constitute a great part of their studies. This knowledge, the result both of reading and of experience, physicians have carried with them into the field.

But it is not in the power of surgeons to enforce the rules of hygiene in these respects without the support of their commanding officers; and they have not always been able, therefore, to apply their knowledge successfully in the management of the interior police of the camps. Indeed, we are compelled to say that there are very few officers in the volunteer service who understand the relations of these matters as physicians understand them. Our views upon the subject of cleanliness among troops have a much wider scope than theirs. We see in the lack of sanitary police, not merely a temporary inconvenience, but the ultimate defeat and disorganization of our armies.

When no attention is paid to habits of personal cleanliness, when garbage lies everywhere in the company streets, and the air has a noisome odor both within and without the tents, we have found the men slovenly in their habits of dress, negligent of duty, but particularly attentive to sick call; their muskets are rusty and out of order—their knapsacks are badly packed—they are improvident of their rations, and their cooking is badly done—they fall into line slowly and straggle on the march—they are insubordinate, mutinous, without drill and without discipline. They have no *esprit de corps*—no self-respect—no manliness—no courage; and they will not fight. These are the links which compose the chain; with defilement at one end and cowardice at the other; commencing in the camp at Alexandria, and ending in the rout upon the plains of Manassas. They are inseparable, and in our opinion whoever is responsible for the one, is responsible for the whole.

"Give me," said Major-General Keyes, when, after our weary march of seven days, we first came in sight of the James river, "give me the two best regiments in my

command; I wish to post them at Turkey's Island Bridge;" and after a moment's pause, he added: "The 2d Rhode Island and the 7th Mass." We could have anticipated his choice, for we had inspected their camps often; and we had already learned from experience, what Gen. Keyes understood equally well, that troops whose persons and quarters were always clean never suffered their reputation to be soiled in battle.

Col. Russel, who commanded the 7th Mass., and Col. Frank Wheaton, who commanded the 2d Rhode Island, have both been promoted to the rank of Brigadier-Generals, as they well deserved to be; but in our opinion the effectiveness, value, and bravery of these two regiments, were no less due to the splendid talents of their respective Colonels than to the perfect system of camp police maintained from day to day by Surgeons Holman and Carr.

Says Dr. Mann:

"Cleanliness is the life of an army, while filth and dirt are among its disease-generating causes. The observance of cleanliness in domestic life is of the highest importance to secure the body in health. It is no less valuable as a means of supporting the strength and efficient force of an army in actual service.

"Filth and dirt become more active destroyers of life when they coöperate with pestilential states of atmosphere, insalubrious gases, the production of unhealthy climates or noxious situations. Cleanliness should be enforced upon soldiers with most rigid laws. The code under the Jewish dispensation, enforcing ablutions and purifications, was obeyed as a rigid rite; it has been quoted as a system well adapted to a camp. It has been observed that those regiments which have been subjected to rigid discipline, and where cleanliness has been strongly enforced, have enjoyed higher states of health than those who have been inattentive to this duty. * * * * *

"There was one regiment on the frontiers which at one time counted nine hundred strong, but was reduced by a total want of

good police to less than two hundred fit for duty in the course of two months. This regiment, in its appearance, was at that time dirty in the extreme. To save the remains, if possible, General Dearborn found it necessary to place it under the command of Colonel Miller (now General), by annexing it to his regiment. At one period more than three hundred and forty of this regiment were in hospitals; in addition to these, a large number were reported sick in camp.

"At the close of the war, this regiment had established a high reputation. Its good discipline and bravery were excelled by none.

"The regiments of heavy and light artillery suffered less by disease during the war than any other regiments on the northern frontiers. It is unnecessary to observe, these regiments are always subject to correct discipline; and their better health may be much imputed to cleanliness. Their quarters and encampments were generally in the best state; the men were, mostly, neat and clean in their dress and appearance."

SECTION III.—DRESS. This is a matter having intimate relations to general hygiene. Yet, we regret to say that, in the selection of the materials and in the construction of a soldier's dress, there is too often more regard paid to the general effect than to the comfort and health of the wearer. No doubt something must be conceded to the exterior appearance of troops; there needs to be a proportion and harmony, and perhaps a certain amount of "millinery," in order to the preservation of a proper military effect; but we think that this never need to interfere with the quality, form, or abundant and suitable supply of clothing.

The dress ought to be suited to the climate, season, and to the character or nature of the expedition in which the troops are to be employed. In this climate, during most of the season, the general object of dress is to protect the surface of the body from cold; and that it may not at the same time interfere with perfect freedom of motion, it needs to be warm, light, and free.

The cap should be light, and with ample space within the crown for ventilation. We have seen several regiments of Zouaves, in the American service, furnished with tight-fitting skull-caps, which afford neither protection against the cold nor the direct rays of the sun; and, when we consider that these regiments are composed of raw recruits, men mostly accustomed to wear hats or high-topped caps, and that they have been submitted immediately after enlistment to "cropping," by which they are deprived of the ordinary protection of the hair, we must see that they will suffer greatly in a warm climate and during the intense heat of the summer. The cap ought to be at the same time a protection against the extreme vicissitudes of heat and cold, against rain and snow; and, moreover, it may be firm enough to become a partial defence against the stroke of an enemy's sabre. In no case ought the front piece or visor to be omitted. Soldiers without this important protection are very subject to ophthalmia. For a warm climate there is nothing equal to the white or grey, broad-brimmed or "slouched" felt hat; nor is it particularly unsuitable for cold weather. The "Ulster Guards" introduced this form of head cover; and with one side looped up, and embellished with a cockade, the appearance was not unlike that of the old Revolutionary or "Continental" cocked hat, and the entire *coup d'œil*, even in a military point of view, was very fine. The slouched hat also protects the neck more effectually than any other form of hat from rain. The beard should be worn long, and there will be then no positive necessity for a cravat to protect the neck. If, however, a cravat must be worn, we must at least enter our protest against the high, leather, firm, military stock, which has so long been regarded as essential to the completion of a soldier's costume, but

which, we are happy to say, is now entirely discarded in our service.

The outer waistcoat, or vest, ought to be light and free. For this purpose, plain or twilled grey, or brown flannel, answers the purpose exceedingly well.

The coat needs to be made of a firmer material; yet, while it is compact, it ought not to be heavy. Substantial light-blue broadcloth, or, in warm weather, the light navy flannel, may serve as proper examples of the kind of material which is most suitable for an under-coat. In order to protect the front of the chest well in cold weather, it should be double-breasted. Lining the front with thick layers of cotton batting, crowding the arms into tight sleeves, and making the whole fit smoothly and snugly at the expense of the lungs, may add to the appearance of a soldier upon parade, but they are measures of doubtful utility upon a march or in the heat of action.

The overcoat should be especially the study of the military surgeon. This is not to be worn constantly, but it is intended as a protection against the cold, the rain, and chilling damps of the night air. If properly constructed, it may also serve in an emergency instead of a blanket.

The military cloak, after the pattern of the Portugal cloak, long enough to protect the knees, made of compact duffel, firm and impenetrable to water, and remarkably light, may serve as a sample of what would be found most useful.

The United States naval military overcoat has nearly all the qualities required in this article of a soldier's dress. It is seamless, compact, firm, almost impenetrable to water, and remarkably light.

In addition to the movable cape, a capote or hood, to be drawn over the head in a storm, and to serve as a nightcap

in a bivouac, will often prove a source of comfort. According to Dr. Dumbrech, "every Turkish soldier carries this about with him; it is of strong woollen cloth; two broad straps, a yard long each, are attached to it; these, when the hood is pulled on, are brought round the jaws, covering the mouth, and forming an excellent protection against inclement weather and malaria." We have seen them made to fit snugly to the cap, and over the visor; but they are better when open and loose, and when so constructed that they can be worn with any form of head cover.

The pantaloons in the summer may be linen or cotton; but in the winter, or in rainy seasons, woollen. They should be large and free, especially about the knees, so as in no measure to impede progression. If made somewhat smaller at the bottom, they can be easily tucked into half boots, and thus the ankles may be secured against the wet.

The question whether soldiers, at least in warm climates, ought to wear flannel or cotton next to the skin, as an under-waistcoat, has been much discussed by army medical writers, and the conclusion to which they have generally arrived has been, that flannel is preferable. It is claimed for flannel that, while, if made of some thin material, it does not add much to the actual warmth of the body, being a bad conductor of heat, it protects the surface against the influence of sudden changes of temperature, it absorbs the perspiration, and by some it is regarded as a protection of considerable value against malarial poisons, especially when worn at night.

For ourselves, we confess that, after considerable experience, we do not hesitate in giving the preference to flannel. Broad flannel bands placed around the abdomen make tolerable substitutes for shirts. In the winter season

we regard a thick flannel undershirt as absolutely indispensable.

Drawers may be necessary in the winter, but they are not needed in the summer.

Upon the proper construction and quality of the boots or shoes, it will be readily understood, depends much of the comfort of the soldier. The necessary elements are good leather, sufficient height not to chafe the ankles, a half boot is the best; with a thick and broad sole.

The socks may be cotton or woollen, but in either case it is well to place, when a long march is to be made, a piece of Canton flannel between the sock and the sole of the shoe, which will serve the triple purpose of protecting the foot from the leather, of absorbing the moisture, and by its gentle sliding motion, of preventing friction.

In addition to the points mentioned as necessary to be considered in the construction of a soldier's dress, and which relate chiefly to hygiene, there are other points in which it is to be studied, having reference solely to his immediate protection and serviceability upon the field. Any uniform which is so complicated with trappings that it cannot be easily put on in case of a surprise, is objectionable; since, in the haste and confusion of the moment, the soldier might omit some portion of which he stands in the greatest need. The simplest costume is, therefore, other things being equal, always the best. Garibaldi's heroes, and, during the Mexican campaign, many of our own soldiers, fought in flannel shirts and trowsers.

Also all bright colors, which do not blend easily with the colors of the ground, are ill adapted to military purposes. In this respect red and black are especially objectionable, since they form conspicuous targets for the enemy's rifles. Dark green is also visible at a great dis-

tance, and is fitted only for the costume of soldiers employed as wood rangers in Indian warfare. Even dark blue makes a clearly defined spot upon the background of an ordinary landscape, and when snow covers the ground, no color is so distinctly visible. Light green, light blue, brown, or yellow, are the colors which are soonest lost in an ordinary perspective. Butternut brown and grey are the colors which have been mostly worn by the Confederates during the present war; and our sharpshooters have often assured us that for this reason it is difficult at long range to make a good sight upon either their officers or privates.

SECTION IV.—EXERCISE. One who is not familiar with the habits of soldiers, might think it superfluous to enjoin upon them the necessity of exercise: but during a time of peace, or whenever the men are in permanent encampments, in barracks, or in cantonment, there is found to be a constant disposition to indolence; and for this reason, if we would keep them in health and in condition for service, regular and systematic exercise is necessary.

"The Roman soldiers were exercised daily in the Campus Martius when it was fair weather, and under cover when it rained or snowed." By which they were always in complete training for active service. How much this systematic exercise is worth, every experienced officer well understands.

The men ought to be summoned early in the morning, and be subjected to a severe drill, and once more, or oftener, during the day the drill should be repeated: the exercise consisting in the use of their weapons, in running, jumping, leaping, climbing, and, if possible, also in swimming. In short, the troops should be daily practised in all those exercises which might in any case prove useful in a time of war.

As far as practicable, the same exercises should be continued when soldiers are being conveyed from one post to another upon transports.

SECTION V.—VACCINATION. Soldiers, as soon as they are enlisted, should be vaccinated, unless they bear the marks of having had the small-pox; and if the first vaccination is not entirely satisfactory, it should be repeated.

Vaccine virus can be obtained at all times by requisition upon the Surgeon-General.

It was rumored in 1862 that contractors were in the habit of sending their cloth "into all the pestiferous dens of New York" to be made up, and that from this source the small-pox was frequently introduced into the army. Whatever may be the explanation, it is certain that in our armies, as has been the case in almost all the armies of Europe for the last few centuries, small-pox is almost constantly present to a greater or less extent whenever the troops are accumulated in large numbers—and that nothing but the most vigilant attention to vaccination among recruits could have prevented its rapid extension. Northern troops, especially those who are native born, are in general found to be thoroughly protected by vaccination; but among the troops received in Kentucky, Tennessee, and Missouri, the protection was much less complete, and they have consequently suffered more from this terrible disease.

CHAPTER IV.

BIVOUAC, ACCOMMODATION OF TROOPS IN TENTS, BARRACKS, BILLETS, HUTS, ETC.

SECTION I.—BIVOUAC. A "bivouac" is the watch or guard of troops upon a field without shelter, and is only resorted to in an emergency, when the tents are not brought up, or the immediate presence of an enemy renders it unsafe to repose under their cover, as upon the eve of battle, or after a battle, when the army occupies for the night the field of the day's conquest. Sometimes, also, soldiers are compelled to bivouac in hurried retreats.

Little opportunity is therefore left for the selection of ground with a view to its healthfulness; yet a prudent officer will never omit to choose the most healthy as well as protected points, whenever this is consistent with the strictly military exigencies of the case. Except under an urgent necessity, he will not oblige his soldiers to bivouac upon a wet or marshy soil, where even a single night's exposure might give rise to dangerous fevers; nor, when the ground is covered with snow, or the winds are cold, will the bivouac be made upon bleak and greatly exposed situations.

Possibly a position may be found in the summer which is dry, or in the winter which is under the protection of a forest or of a hill, and which is at the same time convenient to water, wood, and straw or hay.

In the winter, also, unless it is important not to notify the enemy of the position of the army, where the necessary

fuel can be obtained, fires may be built, and the men should be directed to lie about in groups, so as to keep each other warm, with their feet directed towards the fires.

A group may be composed of three or four men, with their blankets spread out underneath and over them, resting upon their knapsacks, with their hoods or blankets drawn over their heads and ears.

Millingen suggests that, when it is desirable not to show an extensive front, the fires should be lighted in circular clusters, that the men may lie between them, and the heat be more generally diffused.

The snow, when it is of sufficient depth, may be thrown into banks or ridges, under the lee of which the men may repose; or they may lie partly imbedded in it; or they may even, where there are heavy embankments, creep into holes which they have excavated, and find themselves greatly the gainers. Millingen adds, that "incredible comfort will arise from anointing the face and ears with oil before retiring to rest or going upon duty."

"In very cold weather," says Millingen, "the sentries should only be kept on an hour; and when relieved, the men should not be permitted to lie down immediately by the fires, but be kept pacing around them till the sensation of numbness is relieved."

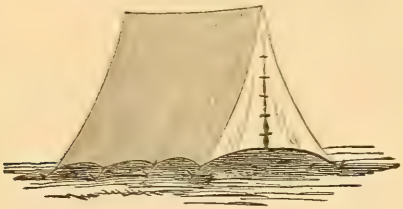
It is scarcely necessary to say that, in all cases, the sick and wounded should have the preference in accommodations, and that to them should be assigned the barns or houses, or such other more comfortable places of shelter as may happen to be within reach.

SECTION II.—ENCAMPMENT IN TENTS. Although the selection of the material and the plan of construction of the tents are not supposed to be in any respect under the

direction of the army medical boards or of the medical staff officers, except so far as relates to the hospital tents, it is nevertheless deemed proper, in this place, to say a few words upon these points, since they are so closely connected with the comfort and hygiene of the troops.

The tents usually employed in this country by the army are the common A or wedge tent, the wall, and the Sibley tent.

FIG. 1.

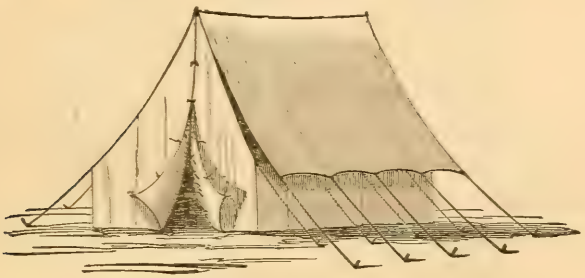


WEDGE TENT.

In the Army of the Cumberland we found in April, 1863, the "bell" tent in use by a few of the regiments. It is open at both ends, and furnished with a window upon one side, and is, in our judgment, superior to the Sibley tent.

The wedge tent is constructed of strong canvas, and it

FIG. 2.



OFFICERS' WALL TENT.

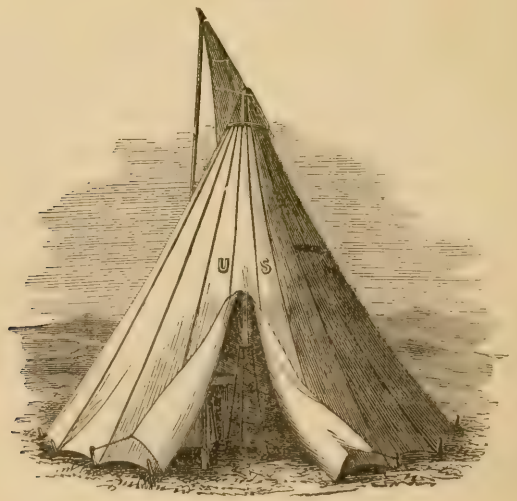
may be considered, when pitched with the proper inclination, as nearly water-proof. During heavy and continued rain-storms, however, it will generally be found to drip a

little within a foot or two of the bottom, so that it is hardly a protection to those who lie near the sod-cloth or outer margin.

The following description of the Sibley tent is copied from an excellent handbook, entitled "Prairie Traveller," by Captain Marcy of the U.S.A.

"A tent has been invented by Major H. H. Sibley of the army, which is known as the 'Sibley Tent.' It is somewhat similar to the Camanche lodge. But in place of the conical frame-work of poles, it has one upright standard, resting upon an iron tripod in the centre. The tripod can be used to sustain cooking utensils over the fire, and, when folded up, admits the wooden standard between the legs, thereby reducing the length one-half, and making it more convenient for packing and travelling.

FIG. 8.

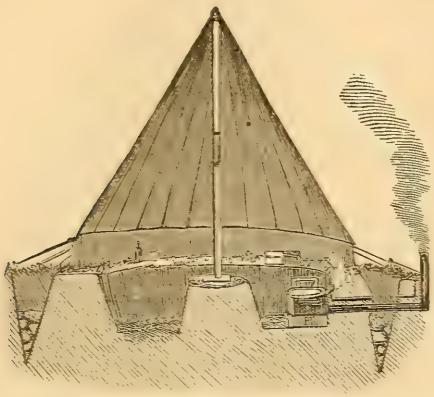


SIBLEY TENT.

"This tent constituted the entire shelter of the army in Utah during the winter of 1857–8, and, notwithstanding the severity of the climate in the elevated locality of Camp Scott, the troops were quite comfortable and pleased with the tent.

"In permanent camps the Sibley tent may be so pitched as to give more room by erecting a tripod upon the outside with three poles, high and stout enough to admit of the tent's being suspended by ropes attached to the apex. This method dispenses with the necessity of the central upright standard.

FIG. 4.



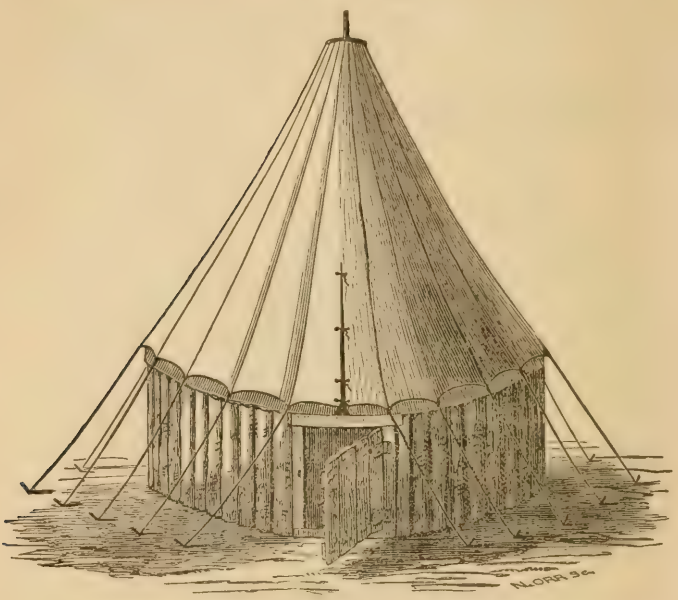
TENT WITH EXCAVATED BASEMENT.

"When the weather is very cold, the tent may be made warmer by excavating a basement about three feet deep, which also gives a wall to the tent, making it more roomy, or it may be stockaded with logs set vertically, or heavy ash, oak, or pine splittings. (Fig. 5.)

"The Sibley tent in the army is intended to accommodate fifteen men, but not more than ten can be made comfortable in it.

"Captain G. Rhodes, of the English Army, in his recent work on Tents and Tent-life, has given a description of most of the tents used in the different armies in Europe, but, in my judgment, none of them, in point of convenience, comfort, and economy, will compare with the Sibley tent for campaigning in *cold* weather. One of its most important features, that of admitting a fire within it, and of causing a draught by the disposition of the 'wings,' is not, that I am aware, possessed by any other tent. Moreover, it is exempt from the objections that are urged against some other tents, on account of insalubrity from want of top ventilation to carry off the impure air during the night."

Fig. 5.



SIBLEY TENT, STOCKADED.

The "wings" spoken of by Captain Marcy are copied from the Camanche lodge, and are suspended above and to one side of the apex of the tent, for the purpose of controlling the draught of air.

The Sibley tent is still retained in the United States Army Regulations, especially as a *hospital tent;* yet very few have been issued for this purpose during the present war; great numbers have, however, been ordered for the officers and soldiers belonging to the various regiments, and especially for the cavalry.

We do not think that it is, on the whole, equal to the wedge tent for common use, especially in warm climates. In hot weather it is very uncomfortable, and in rain-storms it affords imperfect protection. It is in fact

only suitable for cold weather. There is not room enough near the bottom, and unless it is strained very tight, it drips water near the sod, just where the heads of the men are usually laid. It is almost impossible to put even ten men in these tents, if laid upon bunks lifted from the ground.

In some of the encampments we have seen a tent resembling the Sibley, except that it has no opening at the top, and it is constructed with a perpendicular wall. Still more lately, in the Army of the Cumberland, we have seen the Sibley tent made with a perpendicular wall of about three feet in height, which renders it much more spacious and comfortable.

In 1837 the French introduced a tent which they called the "tente d'abri," which was much used in the Crimea, and which has been highly spoken of by various writers; but it is only suitable for the summer season, or for warm climates. "It is composed of two, four, or six square pieces of cloth, with buttons and button-holes adjusted upon the edges, and is pitched by planting two upright stakes in the ground at a distance corresponding with the length of the canvas when buttoned. The two sticks are connected by a cord passed around the top of each, drawn tight, and the ends made fast to pins driven firmly in the ground. The canvas is then laid over the rope between the sticks, spread out at an angle of about forty-five degrees, and the lower edges secured to the earth with wooden pins. This makes some defence against the weather, and was the only shelter employed by the mass of the French army in the Crimea up to October, 1855. For a permanent camp, it is usual to excavate a shallow basement under the tent, and to bank up the earth on the outside in cold weather. It is designed that upon marches the *tente d'abri* shall be taken to pieces and carried by the soldiers."

Similar tents were furnished to the armies of the United States during the summer campaigns of 1862, '63, and '64. The Army of the Potomac received its shelter-tents about the first of March, 1862; and while lying at Catlit's St. in Virginia, on the 6th, 7th, and 8th of April, there was a severe north-easterly storm, with rain and snow, and the men suffered greatly; but later in the season they were found very serviceable. The troops in Major-General Rosecrans's army at Murfreesboro, Tenn., received their shelter-tents about the 1st of April, 1863; and although the men, in derision, called them "dog-kennels," they soon learned to like them very much; most of the soldiers constructed stockades with staves made of wide black-oak splittings, and made use of the tents as roofing. This gave them more room, and enabled them to lift their bunks from the ground.

Within a few years a tent has been constructed by Mr. John Rider, of this city, composed of gutta-percha cloth, and which he has called the "tent-knapsack." It resembles the "tente d'abri" of the French, and is pitched in the same manner; but while it is not so light, and not so cool in summer, it possesses these two advantages over the French tent, namely, it is completely impervious to water, and each separate piece is easily convertible into a waterproof knapsack. The following is a description of the tent:

"It is a piece of gutta-percha five feet three inches long, and three feet eight inches wide, with double edges on one side, and brass studs and button-holes along the edges, and straps and buckles on the fourth edge; the whole weighing three pounds; two sticks, three feet eight inches long by one and a quarter inch in diameter, and a small cord. When used as a knapsack, the clothing is packed in a cotton bag, and the gutta-percha is folded around it, lapping at the ends. The clothing is thus protected by two or three thicknesses of gutta-percha, and

in this respect there is a superiority over the knapsack now used by our troops.

FIG. 4.

ARMY'S TENT-EQUIPAGE.

"When used as a shelter, the sheet, composed of four knapsacks, is ten feet six inches long and seven feet four inches wide, and when pitched on a rope four feet four inches above the ground, covers a horizontal space six feet six inches wide, and seven feet four inches long, which will accommodate five men, and may be made to shelter seven. The sheet can also be used on the ground, and is a great protection from dampness, and as a shawl or mina: indeed, a variety of advantageous uses to which the gutta-percha sheet may be put, will suggest themselves to persons using it."

A very excellent shade tent, made of gutta-percha cloth, has been constructed by Mr. Horace Day, of this city, which is in some respects superior to the Rider tent; but

neither of these tents has yet been much used by our government.

The hospital tent, according to the Army Regulations adopted in 1860, is fourteen feet in length, fifteen feet in width, eleven feet in the ridge, with a four and a half foot wall, and a "fly" of appropriate size. The ridge-pole is made in two sections, and measures fourteen feet when joined. This tent is intended to accommodate from eight to ten patients. The Army Medical Board, at the time of the adoption of these Regulations, recommended that each regiment should be supplied with three of these hospital tents, one Sibley tent, and one common tent, all of which are designed for hospital use.

The regiments have rarely, during the present war, been supplied with more than two hospital tents, and in no instance, so far as we know, with the full complement recommended.

In selecting a site for the tents the same precautions should be observed as in a bivouac, even though the tents are to remain only for a single night. But these precautions become still more important when the encampment is intended to be permanent or stationary. The position must be chosen with a view to the accessibility of water, wood, etc.; but with especial view to the comfort and healthfulness of the soldiers. In the winter the encampment may be under the shelter of a hill or of a forest; but in the summer or autumn an unbroken and somewhat elevated plain, if dry, is generally to be preferred: remote from forests, fallow fields, marshes, stagnant pools, or other well known sources of malaria.

A gentle declivity, near a running stream, has the advantage of affording to the encampment the most complete drainage. If possible, let those whose duty it is to make

the selection, avoid an alluvial soil or a soil composed of clay. A gravelly or rocky field is better, but no soil allows of such complete drainage as that which is sandy.

If it becomes necessary to encamp near a marsh, the tents should be closed tightly on that side which is directly exposed to the malaria.

In stationary encampments many other precautions become necessary. Permanent provisions should be made for a supply of straw or hay, to be laid upon the ground as a protection against dampness at night. It is a common impression that it is of less consequence to protect the under side of the body than the upper; and that if the upper side is well covered, the lower, being in contact with the ground, will take care of itself. There is no more fatal error. The earth almost always contains sufficient moisture to penetrate the clothing; and even where there is no malarial poison, the dampness alone proves a frequent source of rheumatism, pleurisy, and various other inflammatory affections. A bed of straw, or of hay, or of the boughs of trees, contributes both to the comfort and health of the men. We have used for this purpose especially the small boughs of the cedar, which are soft, elastic, and give out a grateful odor.

If possible, all the men should be raised from the ground; and to this end our men have sometimes constructed bunks from boards; or with side rails elevated upon crotchets, they have laid upon these barrel-staves, or boards from cracker boxes; or they have used long cedar or ash poles, of which eight or ten, laid side and side, make a much more comfortable bed than one would suppose; the poles being sufficiently elastic to accommodate themselves to the weight of the body. Some of the German soldiers have woven for themselves mattresses of straw, and others have made very luxurious swinging hammocks of grape-vines.

In dry weather the tents should be opened freely during the entire day for the purpose of ventilation, and the straw or other bedding laid outside. Occasionally new straw or browse should be substituted for the old.

Drains must be dug about all the tents, of uniform depth, and communicating with the mains in the streets.

Various plans have been contrived by our soldiers for warming their tents during the winter months, and especially while in winter quarters. It is a common practice to elevate the tent three or four feet with logs, or in other words to construct a small cabin and cover it with the tent; in this they place a small sheet-iron stove, resembling a piece of ten-inch pipe, and about eighteen inches in length, closed at the bottom, except that a small opening is left for the admission of air; the top is closed by a movable sheet-iron cover perforated with a hole four inches in diameter, upon which the coffee-pot may be set, and through which the wood may be dropped into the stove. The pipe, composed of a three-inch tin or sheet-iron cylinder, perforates the back of the stove near its top. A stove thus constructed weighs very little, and is quite large enough for a common wedge tent.

Others countersink their tents; and when the soil is dry and easily drained, an excavation of two feet may not be objectionable. They then build at the rear of the tent a regular open fireplace, made of bricks, clay, or turf, with a chimney. Tents warmed in this way have a cheerful aspect, and we are inclined to think are the most healthy and comfortable.

It has been a common practice also to make an excavation near the centre of the tent eighteen inches wide by eighteen inches in depth, and two feet or more in length, the two extremities of which were made to communicate

with the outside of the tent in front and rear by narrow trenches. The whole of the excavation thus made was then walled up and covered over except the centre portion, over which was placed a movable cover of sheet-iron, and over this, but not in contact with it, a wooden lattice-work. These underground furnaces, variously modified, had the advantage of drying the soil and of keeping it constantly warm; but they required much ingenuity to construct them properly, and they were very liable to smoke.

An old camp-kettle pushed into the earth horizontally, in a tent which is countersunk, makes a very good stove. A small hole must be made in the bottom to allow of the escape of the smoke, and the open mouth of the kettle must be presented towards the interior of the tent to receive the wood.

Chimneys have been built of brick, turf, clay, twigs set upright and wattled, or two or three barrels set one upon another, but we have found the turf or clay chimney, where bricks could not be had, always the best. In the underground furnaces, both of the trenches communicating with the deeper excavation in the centre serve alternately as chimneys and draughts, according to the direction of the wind.

Our soldiers have never found it difficult to render their tents comfortable in winter during the present war, so far as temperature is concerned. Indeed, we have observed generally that they were kept too warm for health; and we have always found some who refused to have any fire in their tents or cabins, declaring that they were warm enough, and that they slept better without it.

No offal must be permitted to be thrown down before the tents; and no person who is well should be allowed to make a convenience of any portion of the encampment under a severe penalty.

The latrines must be placed in the rear, upon the lowest ground; they should be narrow and deep, so as to leave as little surface for evaporation as possible; and every day a certain amount of the earth excavated in their construction should be replaced until the whole is covered in, and then new sinks should be dug. When latrines can be placed over running water, this necessity is obviated.

The horses, cattle, hogs, or whatever other animals accompany the army, must be kept as remote from the encampment as possible, and no animals should be slaughtered in the immediate vicinity.

If, in spite of all these precautions, disease of an epidemic character breaks out in the camp, the tents should be struck and the encampment changed.

SECTION III.—HUTTING. In the frontier service in this country, where it is found impossible to procure either stone, brick, or boards for building, log huts are frequently constructed, intended to answer a temporary purpose, perhaps for a single winter, or until other building materials can be obtained. For this purpose trees of from one to two feet in diameter, being deprived of their bark, are formed into cabins or block-houses, with windows, doors, and a hole above at one end, for the escape of the smoke and for ventilation.

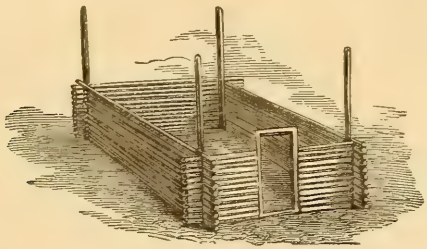
The bark cannot very well be removed except during the months of June, July, or August; and if the season is unfavorable for barking, they ought to be hewn, at least upon two sides.

It is not always possible to choose the size of the timber or the quality; but, if possible, it should be some hard or imperishable material, such as oak, cedar, red beech (the white is more perishable), pine, hemlock, ash, chestnut, or

spruce; maple, poplar, basswood (linden), decay too quickly. In no event, if it can be avoided, ought the cabin to be built of unsound timber, than which nothing can prove a more fruitful source of malaria.

To fill up the chinks between the logs, a small round stick of ash, or any other timber which cleaves easily and straight, may be split into four pieces, and laid edgewise into the spaces, where they are to be retained by wooden pegs.

FIG. 7.



LOG CABIN. (Galton.)

A roof can be constructed of light rafters and carefully split cross-pieces of pine, and over these straw or the bark of oak, hemlock, or beech, may be laid. Shingles can be easily made of pine, hemlock, cedar, chestnut, oak, or spruce, with the aid of an axe or hatchet.

The outside of the building may afterwards be made almost air-tight by plastering between the logs with soft clay.

The cabins should be elevated from the ground so as to allow a free ventilation underneath, whenever sufficient boards can be obtained for a floor; these open sides to be closed in on the approach of winter, with logs or earth.

When the winter has fairly set in, if in a northern climate, the snow may be piled up against the sides of the building; and this will be found to afford an excellent protection against the driving storms and intense cold.

Where logs of sufficient size can be obtained, pickets

are sometimes driven into the ground, and the whole covered in with a roof after a manner similar to that just described.

During the present war, our troops when in permanent encampments, have frequently constructed log huts, especially for guard-houses; but the Confederates have adopted this mode of shelter much more generally than the Federals. We observed this especially at Centreville and Manassas, when in the spring of 1862 we first took possession of those places. We found that nearly or quite the whole army of the Confederates had been sheltered in comfortable cabins, built of unhewn logs, and roofed with shingles; each constructed with one door, one or two small windows, and a large fireplace at one end, the chimney being entirely outside the building.

They were fitted up generally with three or four bunks, being intended to accommodate on the average about this number of men. The cabins were built of uniform size and placed on the line of the streets with great regularity. The officers occupied similar cabins, but larger; the Quartermaster and Commissary stores were sheltered in the same manner. Even the horses had, in some instances, similar but much larger cabins as stables. At a distance these encampments looked like villages or towns of considerable size.

The same form of huts we noticed at Hampton and Ship Point when we first took possession of the Peninsula, and subsequently in the vicinity of Yorktown and Williamsburg.

These cabins resemble precisely those which are seen everywhere in the slave States, and which are used as negro quarters. They were in fact mostly constructed by negroes who were impressed into the service of the Confederate army; and in this way, as in many others, the negroes

have proved to the Confederates an element of great strength.

At Lavergne, in the Department of the Cumberland, we found in May, 1863, an encampment composed entirely of cabins, occupied by the 10th Kentucky Infantry, commanded by Col. Hayes, which in construction, architectural neatness and proportion, and general adaptation to the purposes for which they were intended, exceeded anything which we have seen.

Bunks may be constructed for cabins in the same manner which we have already indicated when speaking of tents.

If lime can be obtained, the interior of the cabin should be thoroughly whitewashed.

Whether for winter or summer use, the precaution ought never to be neglected of digging a ditch, at least eight inches deep, around each hut, to catch and drain off the water.

Sometimes cabins are built against the side of a hill for protection and then covered in with earth; or, as was practised in the Crimea, excavations are made in the earth, and these are simply roofed over. Our own soldiers occasionally adopted the latter method in their winter campaigns in Virginia, countersinking to the depth of two or three feet, and covering the space thus excavated with their wedge tents. This method does very well during the winter when the soil is dry, but in the summer, or in the extreme Southern latitudes at any season, it is objectionable; the habitations being generally damp and giving rise to fevers and congestions.

A much better plan is to construct walls to the height of from two to four feet, and place the tent over this as a cover. The walls may be built of logs, laid upon each other and

Fig. 8.

UNDERGROUND HUT.

joined, or of smaller timber set perpendicularly, like a stockade, or of large oak or ash splittings driven into the ground in the same manner, or of boards. This allows one or two tiers of bunks to be placed inside the tents, one above the other.

At Suffolk, Virginia, on the Blackwater, we found in September, 1862, a large number of mud-hovels which had been used by the Confederates. Our troops had taken possession of them, but they were found to be cold and damp, and we recommended that they should be abandoned immediately.

For the cabins intended for the sick, the best situations should be chosen. If possible, a floor should be constructed sufficiently elevated and open below, so that the air may get underneath.

In the French and English armies, movable wooden huts have been employed to a considerable extent, especially in permanent encampments.

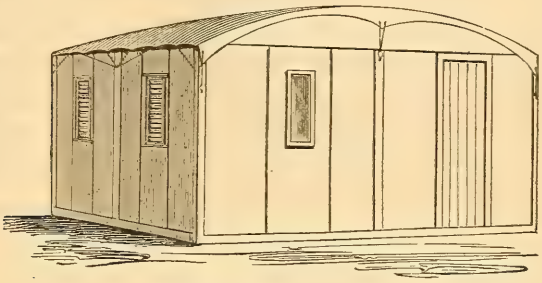
We have seen several patterns of these huts which the inventors sought to have introduced into our armies, but we believe without success. They have been used to a limited extent on the field by sutlers, but the Government has not to our knowledge ordered any for the troops.

Mr. A. Derrom of Patterson, N. J., has constructed a hut of this kind, twelve feet square, weighing 1000 lbs., but which may be reduced to 600 lbs.

It is composed of light thin boards, laid over slight timbers, roofed with painted canvas, or gutta-percha, or India-rubber cloth or wood, as may be preferred, and floored with boards. The whole can be taken to pieces in ten minutes and packed easily in a wagon. They may be put up separately, or any number of them can be joined together.

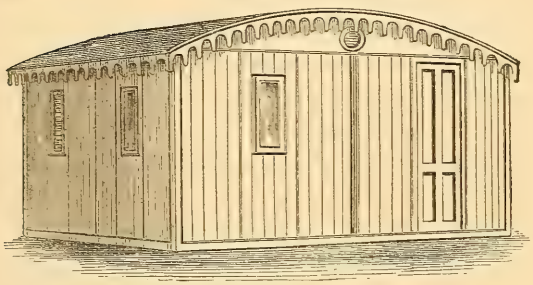
It is our opinion that in a country and climate like ours, these wooden huts are not needed. Forest trees are abundant, and for permanent winter encampments, log cabins

FIG. 9.



DERROM'S HUT FOR PRIVATES.

FIG. 10.



DERROM'S TENT FOR OFFICERS.

can be easily and speedily constructed, while for summer encampments, or for the use of the soldiers when on the march, tents, as being much less cumbersome, are greatly to be preferred.

SECTION IV.—BILLETING. Sometimes it is found necessary, when troops are on duty at or near a town, or are passing through, on account of the inclemency of the weather, or the want of shelter and food for the men, to assign them to lodgings in such private dwellings or public inns as may

be found most convenient; each family being required to receive and entertain a certain number.

It need scarcely be said that nothing but the most pressing necessity can justify this practice, even in an enemy's country, since it is no less subversive of discipline among the men than a source of annoyance to the families.

It has been much more common during the present war to seize upon houses, both public and private, which have been abandoned, or which the military authorities have confiscated, and appropriate them to hospital purposes, to store-rooms, to officers' quarters, and to barracks for the use of the soldiers and laborers.

In our judgment it is both just and proper that these buildings should be appropriated to all such purposes, except as quarters for the officers and enlisted men. Indeed, a considerable experience leads us to say that it would be better for the service if all officers in command of Military Posts, whether on the field, in an enemy's country, or remote from the field, at least during the continuance of active war, should occupy tents outside of the town, and compel all their Field and Staff Officers to do the same.

By this practice their attention would be less likely to be diverted from the performance of their appropriate duties, and their moral, physical and military discipline would be more effectually guaranteed. We have in this country, certainly, many Capuas, although we may not find many Hannibals.

It is no less unfortunate when enlisted men are compelled to take quarters in a town. If the dwellings assigned to them are not always so comfortable as those assigned to their officers, yet their habits will generally be found to be not much less dissipated; and neither discipline, morals, nor sanitary police are possible under these circumstances.

SECTION V.—BARRACKS. Barracks being intended for permanent occupancy, especial care and judgment should be exercised in the selection of a site, and in their construction. It is not only necessary here to regard the convenience to water and wood, the accessibility of supplies, the character of the soil in reference to drainage, the elevation, the proximity to marshes and stagnant pools, to forests, and to fallow fields—upon all of which points information may be obtained by personal inspection—but it is proper also to ascertain by inquiry, especially from medical men in the vicinity, what diseases have been known to prevail in that locality, either constantly, annually, or at longer intervals; whether typhoid fever, intermittent fevers, the yellow fever, the cholera, or epidemic dysentery, have ever existed in that neighborhood. It is important to learn what are the prevailing winds, and whether the ground upon which the buildings are to be erected is subject to inundations, or has ever been inundated. And it might sometimes be well to ascertain whether mosquitoes, or other troublesome or noxious insects, might not at certain seasons render the post uninhabitable. For this cause, old Fort Poinsett, in Florida, had to be abandoned, and Assistant-Surgeon Head reported Fort Cross as nearly untenable, in the summer months, from the same cause.

Ordinarily, unless some special objection exists, an elevated position will be preferred.

It is the duty of the medical officers not only to aid by their counsels and experience in the selection of a site for the barracks, but also in relation to their construction.

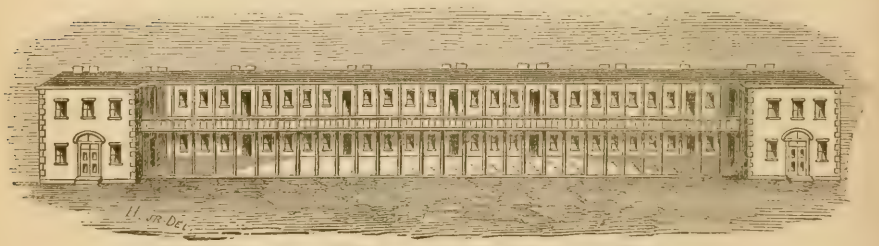
Verandas should be constructed on each side of the building for the convenience of convalescents; and in hot climates the sick are often benefited by having their beds removed to the pure air of the veranda. Detached from

the main building should be a kitchen, laundry, &c. The sinks should also be placed remote from the barracks. The cellars for vegetables ought not to be underneath the main building.

The interior walls should be whitewashed often, and the floors scrubbed with hot water and soap, as frequently as may be necessary for the purpose of cleanliness; yet no doubt this practice has sometimes, especially in cold or wet seasons, been carried to an injurious extent, and especially have rheumatic patients been made to suffer from repeated exposures to a damp atmosphere.

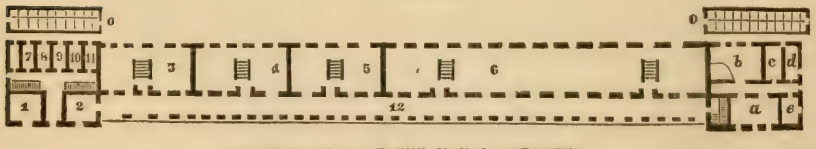
Sometimes dry scrubbing can be properly substituted, or even a careful and thorough sweeping.

FIG. 11.



FRONT ELEVATION OF THE NAVAL BARRACKS AT BROOKLYN, N. Y.

FIG. 12.



GROUND PLAN OF THE NAVAL BARRACKS.

CHAPTER V.

HOSPITALS.

SECTION I.—GENERAL HOSPITALS INTENDED FOR PERMANENT USE. In the erection of permanent hospitals, all considerations relating to location and construction must be made subordinate to the one great purpose for which they are intended, namely, the restoration of the sick to health. If it is not found possible to select a situation which is at least relatively and tolerably salubrious, and to erect or procure a suitable building, it would be far better that the sick should remain without shelter; for it is undoubtedly true that "more human life has been destroyed by accumulating sick men in low and ill-ventilated apartments, than in leaving them exposed in severe and inclement weather at the side of a hedge or common dyke." Sir John Pringle used to say of large military hospitals, as constructed in his day, that they were the "graves of the army;" and to some extent this observation holds true as applied to many of the large military hospitals of this day.

The chief points which are to be kept in view in the location and construction of a permanent hospital are, durability, purity of air, ventilation, warmth in winter, and coolness in summer.

Stone, brick, or iron, are preferable for their durability.

In order to the complete attainment of ventilation the position should be elevated, and the form of the building should be such that all sides may be exposed to the wind. The quadrangular form, with an interior court, is therefore

the most objectionable, unless the quadrangle is composed of small detached buildings, as is the case with the great Naval Hospital at Plymouth, England, the Lariboisière at Paris, and the Military Hospital at Vincennes.

Hospitals of two or three stories may be constructed with a single front, and without wings; but for larger establishments, a building with a single front and two short retiring wings is to be preferred. To the main building are attached, at right angles with its extremities, retiring or salient wings, while at the same time the verandas, placed along the interior, are protected measurably from the intense heats of summer and the driving storms of winter. This is the form of the fine Naval Hospital at Brooklyn.

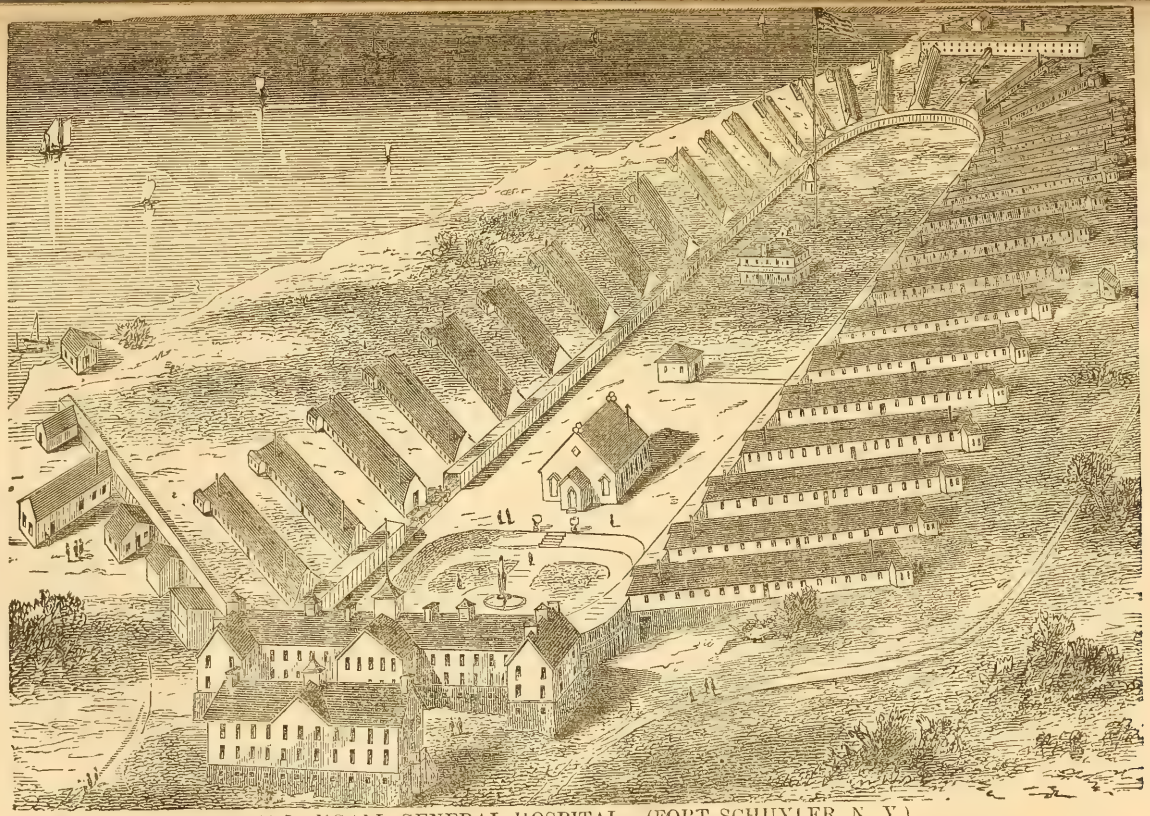
The stellate or radiate form, adopted in the construction of the St. Louis Hospital, at Turin, and in the Hammond United States General Hospital at Point Lookout,* possesses all the advantages of free ventilation, united with convenience of administration.

Of the stellate form there are many modifications.

The McClellan United States Army General Hospital, near Philadelphia, is composed of nine detached pavilions which radiate from the two extremities of a corridor of a flattened ovoidal form.

In the McDougall General Hospital, United States Army, at Fort Schuyler, N. Y., the pavilions are arranged tangential to an oblong corridor, the corridor being furnished with a railway by which the food, medicines, etc., etc., are conveyed. The administrative buildings are at one end, and the kitchen, laundry, etc., at the opposite. The interior contains a chapel, operating room—connected with the wards by railway—a guard-house and a fountain. Water-

* Treatise on Hygiene, by Surgeon-General William. A. Hammond, U.S.A., p. 378.



McDOUGALL GENERAL HOSPITAL. (FORT SCHUYLER, N. Y.)

WARREN WEBSTER, ASSISTANT SURGEON (U.S.A.), IN CHARGE.

closets and bath-rooms are attached to each pavilion, at their further extremities, and entirely outside. Each ward contains forty-eight beds, except those at the end near the kitchen, which are but two-thirds the size of the others. The total capacity of the hospital is 1660 beds. It is situated upon a narrow peninsula, projecting from the main land into the East River, which at high tide is completely surrounded by salt water. This hospital was planned and organized by Assistant-Surgeon Robert Bartholomew, U.S.A., and is now under the excellent management of Warren Webster, Assistant-Surgeon U.S.A. In point of location, McDougall General Hospital cannot be excelled; and in respect to its interior arrangements we have not seen it surpassed by any Hospital in the United States.

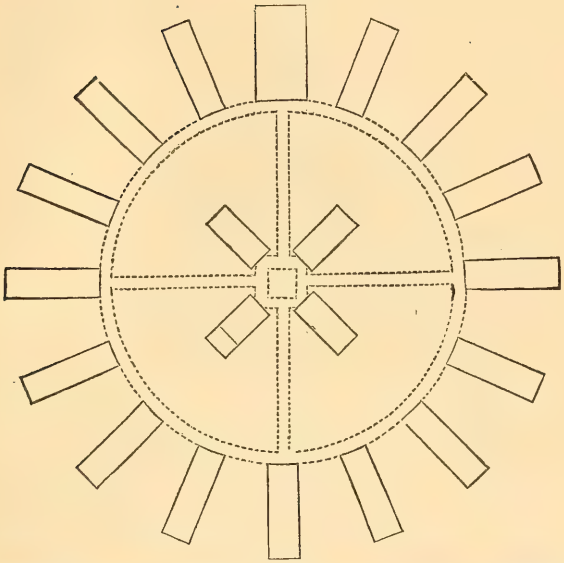
The view which we present is taken from the north-eastern extremity. The first building is the residence of the officers; the second and larger building comprises the administrative offices; at the further extremity is seen the kitchen, laundry, etc.

The Hammond United States Army General Hospital (Fig. 14), at Point Lookout, is a radiate projected from a circular corridor, and is composed of sixteen pavilions, one of which is used for administrative offices. The kitchen, laundry, guard-house, and dead-house, are in the centre of the circular area. Its capacity is 780 beds.

The Mower United States General Hospital at Chestnut Hill, near Philadelphia, is composed of fifty pavilions projecting from a corridor of a flattened ellipsoidal form. It is said to be "the largest institution in the world devoted to the reception of the sick and wounded alone," containing 2820 beds for patients, and 500 for officers and attendants.

The Lincoln Hospital at Washington (Fig. 15), with several others in different parts of the United States, has a corri-

Fig 14.



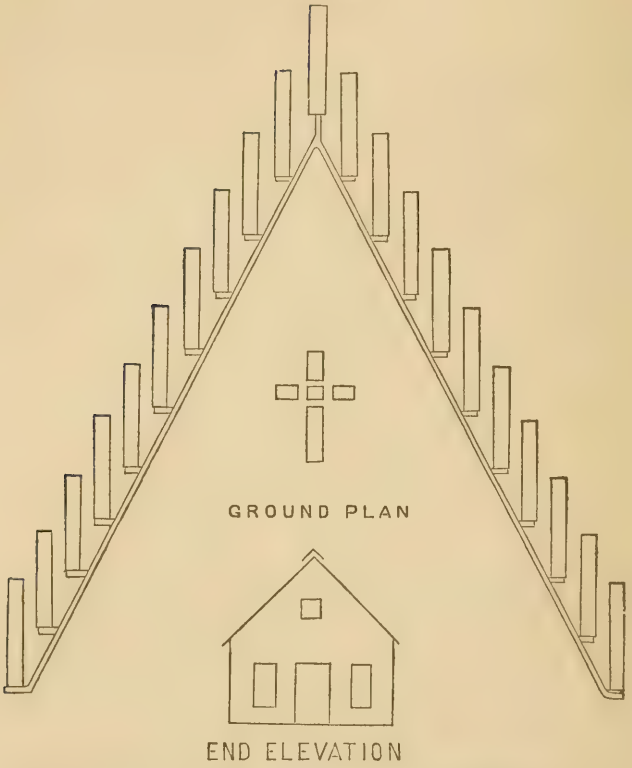
HAMMOND GENERAL HOSPITAL, POINT LOOKOUT. (From Hammond.)

dor in the form of the letter V, the pavilions being placed tangential to the corridor upon its outside, *en échelon*. The administrative building is at the apex; and the kitchen, laundry, etc., are in the centre of the inclosure.

Many of our pavilion hospitals are constructed upon a single, straight corridor, with the wards projecting outwards at regular intervals upon both sides, so that they open opposite to each other on the right and left of the corridor; or they open upon the corridor alternately from the right and left. For the purposes of ventilation the latter arrangement is the best.

A careful observation has convinced us that all Hospitals, and especially Military Hospitals, ought to be one story buildings, elevated three or four feet from the ground. In pavilions we have constantly had the smallest amount of

Fig. 15.



LINCOLN GENERAL HOSPITAL, WASHINGTON CITY. (From Hammond.)

hospital gangrene, pyæmia, and erysipelas; and it is believed that fevers have been less fatal, and convalescence from all maladies has been more rapid and certain. We intend in these remarks to except hospitals established in large, well-made hospital tents, commonly called Field Hospitals, which latter are, in our opinion, the best Military Hospitals for temporary use.

One story buildings possess these several advantages over buildings of two or more stories.

1st. They are more easily ventilated, and this consideration takes precedence of all others. Its importance can never be over-estimated. The best place to treat a sick or wounded man is always, other things being equal, where he can get the most and the purest air. When this doctrine is thoroughly understood, hospitals will cease to be the graves of soldiers, and never until then.

2d. They are much more easy of administration.

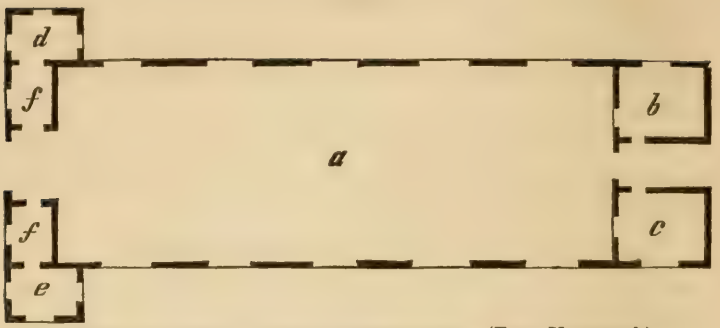
3d. Such of the patients as are able to walk can pass in and out with less fatigue. In lofty buildings, feeble patients and those who are lame, are in many cases as effectually excluded from out-door exercise as if they were bed-ridden.

A pavilion, or any single ward, may be regarded as the unit of a hospital building, and the Surgeon General, in his valuable treatise on Military Hygiene, has furnished us with an excellent standard for its construction.

The ward should be of an oblong shape. The width should be twenty-five feet, which will allow seven feet six inches for each bed—the beds being nine inches from the wall—and eight and a half feet for the passage-way. The length must depend upon the number of beds it is intended to receive. In a permanent hospital each bed should be allowed an average of seven feet in the direction of the length of the ward. Fifty is the maximum of beds—twenty-five on each side. This number of beds would require, therefore, 175 feet. The height of the walls should be fourteen feet, and the roof high pitched. This will give 1205 cubic feet of air to each patient; which is the *minimum* allowance for any ward intended for permanent use.

The windows should be placed in the long sides of the ward, and they should be not less than five feet in height; the beds being arranged in pairs between the windows.

FIG. 16.

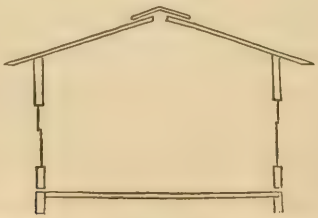


GROUND PLAN FOR A WARD OF TWENTY BEDS. (From Hammond.)

a. Main room.
b, *c*. Ward master's room, and mess-room.
d, *e*. Water-closets.
f, *f*. Bath-rooms.

In addition to the doors and windows, all hospitals require other means of ventilation. Of all the various modes which have been devised, we have seen nothing equal to the so called "ridge ventilation," in which the air is permitted to escape through the entire length of the ridge of the roof; when this plan is combined with a movable base along the whole length of both sides of the ward, as we have seen in a pavilion hospital at Mill Springs, Va., nothing more can be desired. Instead of a movable base the fresh air may be admitted through perforations made at intervals near the floor.

FIG. 17.



SECTION OF A RIDGE VENTILATED WARD—HAMMOND GENERAL HOSPITAL.
(From Hammond.)

In the winter the base may be closed, and the air

admitted directly underneath the stove in the centre of the room, the stove being covered in by a perforated shield or jacket, which receives and warms the air before it is diffused through the ward.

The distance between each two adjacent pavilions should be equal to twice their height, so as to permit free ingress of both air and light.

To every ward there must be attached a bath and wash-room, a water-closet, and a ward-master's room; and perhaps a small mess-room.

For the general administrative department there will be required, moreover, a surgery, an office for the surgeon in charge, quarters for the other medical officers, the stewards, apothecaries, and nurses, an apothecary's office, store-rooms, kitchen, laundry, dead-house, and guard-house.

Section II.—General Hospitals intended for Temporary Use. During a time of war it often becomes necessary to seize upon and appropriate for temporary hospital purposes such public and private buildings as are suitable and as are conveniently located. For this purpose we have taken during the present war large private residences, especially those buildings of this class belonging to rebel citizens who have abandoned their homes, or whose open and active sympathy with the rebellion has rendered it necessary that the government should remove them beyond our lines; but much more frequently we have taken possession of large warehouses and store-rooms, inns, factories, school-houses, academies, colleges, and other seminaries of learning which have been closed by the desertion of their disloyal owners and occupants. We have also taken churches, town halls, and other public buildings belonging to loyal citizens, or to the general gov-

ernment. In the city of Washington the Patent Office, and even the Halls of Congress, the House of Representatives, and the Senate Chamber were used during the summer of 1862 for the wounded soldiers; and at one time the order was issued to occupy the President's Mansion, which order would have been promptly obeyed and cheerfully acceded to by the President had it not seemed to be unnecessary, and had not the order been countermanded on the same day.

These buildings are so various in their construction and in their location, that it is impossible to classify them, or to declare to which we ought to give the preference. Not many of them were in a condition really suitable for hospital purposes when they were first taken, but by the appropriation of very liberal sums of money a few of the whole number have been converted into very excellent hospitals. In the East, especially, some of these buildings have by lavish expenditures been made fit for a more permanent occupancy.

To say nothing of the economy of attempting to convert into hospitals buildings which had originally few if any of the necessary conditions, and for many of which the government is paying enormous rents, it is certain that in a sanitary point of view it would be better if they were never used except in cases of pressing necessity, and that they should then be abandoned as soon as buildings could be constructed upon approved models and in proper situations.

No doubt multitudes have died in warehouses, storerooms, factories, etc., whose lives might have been saved in properly constructed field hospitals.

It may have been some consolation to these unfortunate men to know that here they were surrounded by their

friends, and that if they were to die, it would be in spite of the best medical and surgical skill; but it will hardly compensate for the reflection that if they had been left upon the open field, exposed to all the vicissitudes of weather, but where the air was not infected, they would in all probability sooner or later have been restored to health.

Men taken into these hospitals with diarrhœa or some other simple ailment, have often been attacked with fever; patients recovering from fever have died of erysipelas; wounds which were nearly healed have suddenly been invaded by erysipelas or hospital gangrene, or pyæmia has supervened. In short, there is in most of these buildings a long file of terrible maladies, which are born of impure air, and through which all who pass out of their doors must run; and fortunate indeed is the man who, having once entered, escapes with his life.

With commendable prudence and zeal, the government has sought to remedy this evil as rapidly as possible by the construction of pavilions, or by the erection of hospital tents.

In the construction of pavilions for temporary occupancy, when supplied with good ridge ventilation, 900 cubic feet of air to each bed has been regarded as sufficient, especially in the summer, when the doors and windows can be kept open.

We have before stated that, in our opinion, nothing could equal, in a sanitary point of view, a field hospital composed of large hospital tents or marquées; we have seen these tents in use as general hospitals in midsummer, in the valley of the Tennessee, at Stevenson, Alabama, at Bridgeport, and in this city. In January, 1862, after having organized the Central Park General Hospital in the

city of New York, we found it necessary, on account of the appearance of hospital gangrene, to erect tents, and these tents, eight or ten in number, have been occupied ever since. In neither of these extremes of climate and of season has there been found any difficulty in rendering the tents comfortable.

At Stevenson, Alabama, the hospital was pitched partly under the shelter of large forest trees, the lower limbs, the smaller growths, and the dead leaves having been previously cleared away.

In the Central Park General Hospital the tents were floored, and the side walls battened down during the winter. Two tents were united in one, and the opposite extremities served as doors. One single stove in the centre was found sufficient to make them perfectly comfortable in the coldest weather.

The army hospital tent will contain eight or ten persons, or even more, but when occupied by cases of hospital gangrene, or fever, or badly suppurating wounds, four is the number generally allowed.

One single fact which we shall state ought to settle for ever the value of tents for hospital purposes. While we have seen many hundreds of cases of hospital gangrene which have originated in buildings temporarily occupied, in transports, and even in well constructed pavilions, we have never seen a case which originated in a tent; nor can we call to mind a case which was not at once benefited, if not speedily cured, by a transfer to a tent. Upon this point the testimony of all army surgeons with whom we have conversed is the same.

At the instance of the author, seconded by several other medical gentlemen, the enlightened and liberal Commissioners of Public Charities of the City of New York have

recently established upon Blackwell's Island, in this city, a fever ward composed entirely of hospital tents. We shall now be able to ascertain how much pure air alone can accomplish in typhus and typhoid fevers.

SECTION III.—REGIMENTAL HOSPITALS. The hospital tent now in use in the United States Army is the large wall tent. Its dimensions are fifteen feet in width, fourteen feet in length, height in the centre eleven feet, with a wall four and a half feet, and a fly of appropriate size. Two of these are usually supplied to each regiment; and they are supposed to furnish accommodations ordinarily for twenty men. As a general rule this number of tents has been found to be sufficient, except in times of unusual sickness, or after a battle; and under these circumstances the excess over what the regimental hospitals will accommodate is usually sent to the rear.

When a regiment goes into camp the surgeon proceeds at once to select an appropriate position for his tents; if possible on high ground and near a running stream; and, if the weather is warm, under the shade of large trees.

The two tents are then pitched end to end, and the ground is carefully trenched around the whole. The trench ought to be eighteen inches in depth, and the same in width.

If the surgeon performs his duty properly he will soon be able to make these tents exceedingly comfortable. Such at least has been our experience in all the campaigns we have made. It is not often that the surgeon is furnished during an active campaign with cots or mattresses. He has only a limited supply of woollen and oil cloth blankets.

There are several methods of elevating the patients from

the ground to which the surgeon may resort. He may make separate beds for each man by driving into the ground crotched sticks, laying upon them a couple of side rails, and boarding over the whole with fragments of boxes or staves, or he may adopt any of the other modes of constructing a bed which we have described when speaking of the management of tents. If, however, he desires to make the most room with the least labor, he will construct upon each side a raised daïs, each daïs being six feet in length from the side wall to near the centre of the tent. This will leave along the whole length in the centre of the tent two feet for a passage-way. The daïs should be two feet in height at the foot, and two and a half feet at the head. It may be composed of boards or of saplings laid upon stout crotches. It should be covered heavily with straw, hay, or browse, and over this, first the oil-cloths should be laid, and then the blankets.

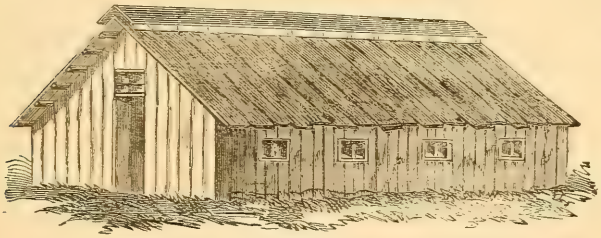
We have seen some of these regimental hospitals rivalling in neatness and comfort the most richly endowed hospitals of the cities. In one, under the charge of Surgeon Holman of 7th Mass. Vols., soon after the Army of the Potomac had arrived at Harrison's Landing, in Va., we found the passage-way between the rows of beds covered with small cedar twigs, which were changed daily; in the rear was a neat little arbor made of cedar trees, which he had planted in a circular form inclosing a grass plat; a rude seat of twigs had been constructed under the shade of the trees; in the ground was buried a box containing some ice which he had managed to save; and still further in the rear was a cow which had been led by one of the hospital attendants across the Peninsula, and which was furnishing his sick men with all the milk they wanted.

We have often had occasion to remark the practical dif-

ference among surgeons in this respect. Some lose their tents—some never pitch them, because they expect to move to-morrow or the next day; and some never can get their tents in order in less than two or four weeks, if they ever do at all. The surgeon of whom we have spoken never lost his tents; they were pitched within one hour after going into camp; and they were in complete order the next day. Such men are invaluable to any commanding officer and to the service.

The following sketch of a ridge ventilated hut may serve as a sample of the kind of rude building which, in an emergency, may be substituted for a tent.

Fig. 18.



RIDGE VENTILATED HUT. (From Hammond.)

Section IV.—Flying Hospitals are Medical Detachments which accompany the army, whether upon the march or in engagements. During an engagement the flying hospital is posted, by order of the senior Staff Surgeon, at some convenient point near the field of battle, in order that the wounded may receive early succor. Occasionally the regular hospital tent is employed as the depôt, at other times a barn, shed, or house may be chosen; but if the weather is pleasant, it may be sufficient to select a spot which is protected from the fire of the enemy, and where water and shade may be found. When tents or

buildings are not resorted to, the term "flying hospital" continues to apply to the medical corps, in whatever direction it may move, or wherever it may chance to be.

At these points the wounded receive their first succor, and most of the minor dressings are made, and some of the major; after which they are sent to the rear, to be placed in such temporary or permanent hospitals as may be provided for them.

In the British Crimean service, during most of the time occupied in the siege, Assistant Surgeons gave the first attention to the wounded before they were sent to the rear. But at the time of an assault, Staff Surgeons were advanced to the ravines, and performed such operations as were necessary on the spot, and attended to the transmission of the wounded to the hospitals. The French also adopted much the same method. They placed ambulances in the ravines, close to the trenches, where balls were extracted, dressings made, etc., after which the wounded were passed to the divisional ambulances.

In the American service, by an order from the War Department, Assistant Surgeons are required to accompany their respective commands to the field of battle; and when the engagement is actually commenced they are expected to retire only a short distance, and under the cover of the nearest shelter to perform all those operations which demand immediate attention. In our general introductory we have given a full account of the manner in which the flying hospitals in the American service are at present arranged and conducted.

CHAPTER VI.

PREPARATIONS FOR THE FIELD.

GUTHRIE says, "A surgeon without his apparatus and equipments is little better than a battery of artillery without ammunition." Yet it is not possible that Surgeons employed in army service should be as well supplied with instruments, apparatus, and medicines as in civil practice; nor that the sick or wounded soldier should receive that attention, or enjoy those comforts of warm and abundant clothing, soft beds, and easy conveyance to which he has in many cases been accustomed; and especially is this true in relation to the immediate provisions for the sick and wounded after a battle, or upon the march. While everything ought to be provided, consistent with the means of the Government, the rapidity of movement of the troops, the peculiarities of the country, the climate, and the nature of the warfare, yet it must be seen that to some extent a soldier's privations must continue even when he becomes a patient. Many things, usually regarded as eminently desirable, must be sacrificed to the necessities of the service. What is necessary must, if possible, be supplied—but luxuries must be left behind; compactness being generally a primary consideration in everything relating to the army when in motion or in active service.

In the United States army each Regimental Surgeon is supplied by the Government with one general operating case, including instruments for trephining and amputating, and one pocket-case. Surgeons in charge of General Hos-

pitals are allowed additional sets of instruments, which may generally be obtained upon requisition.

We have recently had constructed a "Field Case," designed to be used by the surgeons especially when upon the field of battle. Our object has been to comprise within a single case all the instruments which are likely to be needed in an emergency, and which case may be sufficiently compact and light to be easily carried from one point to another. It is not intended to supply all the wants of a hospital, or to complete the armamentarium of the regimental surgeon, but only to obviate the necessity of carrying several cases where only a few instruments are needed.

Messrs. Wade & Ford, Instrument Makers, 85 Fulton street, and also Geo. Tiemann & Co., 63 Chatham street, New York, have put them up very neatly, and made for them a leather case, after the pattern of those used in the army. These instruments are provided mostly for amputation, resection, trephining, ligature of arteries, and simple dressings; since these constitute the major part of the operations usually made upon the field, unless we except the temporary dressing of fractures.

The supply of medicines, books, hospital stores, bedding, furniture, dressings, etc., is ample; certainly all that could reasonably be demanded, and probably quite as much as any Government has ever furnished. The medicines have been found in most cases to be of the best quality; and there is no article in the materia medica which, upon special requisition, may not be obtained, provided it can be found in the market.

Patent or sheet lint is generally furnished to the Medical Officers by the Government, while to the Sanitary Commission we have been indebted for large supplies of scraped lint. Oakum is also now supplied in abundance to the hos-

pitals; an article for the introduction of which as a dressing for suppurating wounds, I believe we are under obligations to Dr. Lewis A. Sayre of this city. For cheapness and general utility, we think it superior to any article heretofore in use.

As an adhesive plaster we have not only the ordinary emplastrum adhesivum, but also in sufficient abundance the emplastrum ichthyocollæ, which is peculiarly serviceable on the field.

The minor splints employed in our army are coarse, rather thick, unglazed binder's board, cut into pieces of eighteen inches by four, for the convenience of packing; splints made of calfskin, veneered with white wood, the latter being subsequently split into strips of about half an inch in width, so as to combine a certain degree of flexibility with the requisite firmness; gutta-percha, in sheets of about two feet in width by two feet in length, and one-sixth of an inch in thickness, and splints made of undressed sole leather. A nest of splints, made of leather, white wood, pine or ash, may be prepared as follows: The first and largest splint, eighteen inches by four; the second, sixteen by three and a half; the third, fourteen by three; the fourth, twelve by two and a half; and the fifth, ten by two; reducing the splints each time by two inches in length and half an inch in breadth.

The supply of major splints furnished to regiments or troops in the field is very limited, these being of little value until the wounded have been gathered into permanent field hospitals or into general hospitals. They consist of Buck's compact, long, straight splints for the leg and thigh, with pulleys for making extension; Smith's anterior splint; Hodgen's "cradle," etc.

The set of splints furnished to the Navy, contrived and

arranged by E. R. Squibb, M.D., late of the United States Navy, consists of

1 double inclined plane. 1 long splint, for fractures of the lower extremities, with a belt and perineal pad and strap. 1 short, curved splint, for the inside of the thigh. 2 curved splints for general use, all of which have pads fitted and tied on them. 1 set of leathered wooden splints (same as in the army).

2 sheets of cotton wadding, and a package of tow accompanying each set of splints. The whole inclosed in a substantial box.

"The double inclined plane has the lower part so arranged as to be easily detached and used separately as a fracture box when required.

"It is also provided with large buttons on the bottom, which when turned cross-wise make the apparatus sit more firmly on the mattress.

"The long splint for the lower extremities is adapted for the use of an adhesive plaster extending band. A strip of adhesive plaster, about two inches wide, is to be applied to the limb, in the direction of its axis, from near the seat of fracture, down one side and up the other, leaving a loop or stirrup under the sole of the foot. The whole is then enveloped with a roller bandage, applied with a moderate degree of firmness. A thin piece of board, about two inches square, is made to adhere to the inside of the loop or stirrup, at the sole of the foot; and around this, and over the hook of the splint, a piece of tape is passed, by which to make extension.

"A pocket is made in the belt, to receive the upper end of the splint; and the buckles on the outside of the pocket receive the ends of the perineal straps for counter-extension.

"To adapt the splint to opposite sides, it is only necessary to take out the hook and adjust it so that the opening looks upward."

We shall consider the value and application of these, and of various other forms of apparatus, in the chapter on gunshot fractures.

The Army Medical Board, convened at Washington, in November, 1859, recommended the adoption of a hospital knapsack, to be carried by a hospital orderly upon the march or in battle, who is habitually to follow the medical officer. The knapsack to be make of light wood; divided into four compartments or drawers, and covered with canvas after Colonel Buchanan's model knapsack. The purpose of this is to carry, in an accessible shape, such instruments, dressings, and medicines, as may be needed in an emergency on the march or in the field. The dimensions of the hospital knapsack to be those of the ordinary knapsack.

During the first two years of the war these knapsacks were furnished in the proportion of about two to each regiment; they were made of willow, however, or of tin.

Experience has proven that these knapsacks were too heavy, and that the amount and variety of medicines, dressings, etc., carried in them was unnecessarily large. The Surgeon-General has therefore had constructed a leather knapsack of about half the original size and weight. Its form also is such that it can be much more conveniently carried upon the back.

For hæmorrhages occurring upon the field, the surgeon and his attendants need to be supplied with what are called field tourniquets, composed usually of a strap and buckle, either with or without a pad. A simple cord applied properly, and twisted upon the limb with a short stick, a pis-

tol, of any other short weapon, may answer the purpose.

Figs. 19 and 20.

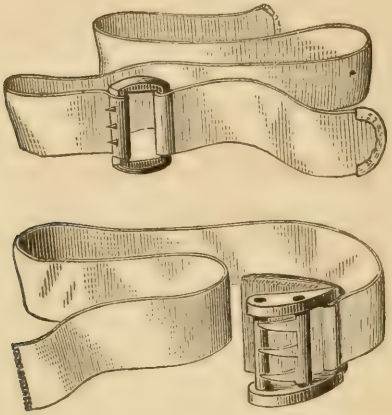


Fig. 21.

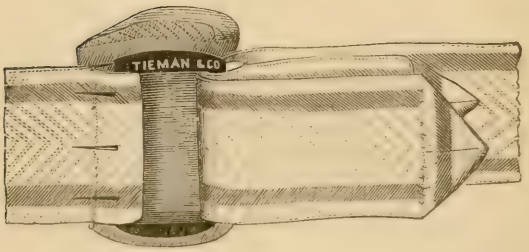


Fig. 19 represents a field tourniquet used in the Prussian service, without a pad; and in which the strap, after passing around the limb, is simply laid over and caught upon the steel points of the buckle.

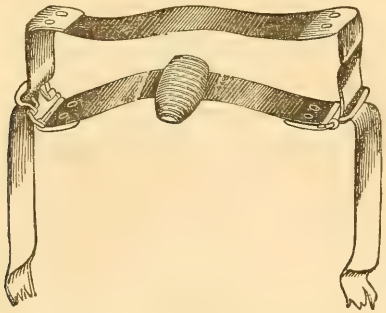
Fig. 20 represents a field tourniquet with a pad, and with the strap passing *through* the buckle in the usual manner.

Fig. 21 represents the same tourniquet slightly modified.

Recently there has been invented by Alexander B. Mott

of this city, Surgeon United States Volunteers, a very ingenious field tourniquet, which is easily applied, and may be considered safe even in the hands of those who know nothing of the danger of ligating limbs too tightly, since the compression is applied at only two points in the circumference of the limb.

Fig. 22.



A. B. MOTT'S FIELD TOURNIQUET.

It is very common to find among returned soldiers who have been attached to the artillery, examples of rupture of the tympanum, with more or less complete deafness, occasioned by the concussion of the air in firing heavy guns. Men who are inexperienced, therefore, in the effects of heavy discharges of artillery upon the drum of the ear, and upon its delicate nerves, ought to be carefully instructed.

Those who are nearest the muzzle feel the report most; and those who are to the leeward suffer more than those who are to the windward. If the gunner stands with the side of his head towards the muzzle of the gun, the shock will be much more painful upon the exposed than upon the opposite ear. He will experience much less inconvenience when he stands with his face square to the muzzle, and least of

all when he presents the back of his head square to the muzzle.

In order still farther to diminish the effects of the concussion upon the entire body, one should stand upon the balls of the feet, the heels not touching the ground. By opening the mouth also the pressure upon the two surfaces of the tympanum is equalized. Some gunners say it is better to close the lips but separate the teeth.

A small pledget of wool or of cotton placed lightly in each ear, and especially if the cotton is previously dipped in sweet oil or glycerine, or even moistened with water, will effectually protect these organs. This method is, however, considered objectionable by commanding officers, because it interferes with the hearing of the word of command.

The surgeon ought himself to see that his instruments, dressings, medicines, stretchers, etc., are all in complete order, and he should himself attend to their distribution and packing, in order that he may always know where to find them.

CHAPTER VII.

HYGIENIC MANAGEMENT OF TROOPS UPON THE MARCH.

FIFTEEN miles per day is considered a fair average for infantry; and upon long marches, ten miles, including all the necessary delays, is accounted good travelling. This will depend much, however, upon the nature of the country, the season of the year, as well as upon whether the troops are newly recruited, or old soldiers accustomed to hardships and to travel.

Some of the longest marches of infantry upon record have been made by American troops. During the first year of the Mexican war, Gen. Kearney was placed in command of the "Army of the West," with instructions to conquer New Mexico and California. He left Fort Leavenworth, Kansas, in June, and after a journey of nine hundred miles over the great plains and mountain ranges, arrived at Santa Fé, the capital of New Mexico, on the 18th of August. In the year 1860, a large portion of the Seventh Regiment marched from Camp Floyd, U. T., to Fort Buchanan, New Mexico, having travelled one thousand miles, and spent one hundred and forty days on the road. But the most unprecedented march of infantry was made by the gallant old Sixth, in 1859, which left Fort Leavenworth, Kansas, for California, a distance of one thousand eight hundred miles, and was one hundred and ninety days on the road, of which one hundred and sixty-two were actually passed in marching, being at the rate of about eleven miles per day.

During the present war, our own armies and the armies of the Confederates have furnished us with numerous examples of long and rapid marches; and in very many instances these marches have been made under an almost constant succession of engagements, demonstrating both the valor and endurance of the American troops.

We may cite as examples which have come to our own knowledge, the famous marches through the Shenandoah Valley of General Shields's Division, in the months of April, May, and June, 1862; during most of which time the troops were under fire, without tents, upon short rations, and during a part of which time the weather was exceedingly inclement; General Buell's march in September and October, 1862, from Louisville, Ky., to Northern Alabama, by a circuitous route, and thence back to Louisville; the march of the troops under General McClellan from Harrison's Landing, Va., to Fortress Monroe, and, being conveyed in transports from thence to Alexandria, their march to Manassas and back; and finally their long and rapid march to South Mountain and Antietam, in Maryland, where they overtook and intercepted General Lee, and fought the decisive battle of Antietam, just one month from the day they left Harrison's Landing; General Sherman's march, in 1863, from Memphis to Chattanooga, from Chattanooga to Knoxville, and back to Chattanooga.

The commanding officer of the 6th Ohio V.I., informed us in the summer of 1863, that during their two years of service, they had travelled on transports 1030 miles, by railroad 515 miles, and on foot 2253 miles; this enumeration not including the marches made in scouting and in reconnoitering.

A large proportion of the army has been, during the past three years, quite as constantly in motion.

Even in warm climates, it is better that the sleep of the soldier should not be broken before day, as what is gained by the avoidance of the heat of the midday, is more than lost by the interruption of the natural rest. A light breakfast of coffee and bread, or potatoes, ought always to precede the march.

The first hour the troops ought not to march, ordinarily, more than two miles; and after an interval of half an hour, during which they should be encouraged to throw off their knapsacks and recline, or to attend to the necessary calls of nature, they should be again set in motion. The distance may be increased the second hour to about two and a half miles; and after resting again half an hour, the line of march may be resumed at the rate of three miles an hour. This ought never to be exceeded, except in forced marches. After three hours' march—four hours, including stops—the troops should be allowed to go into bivouac until past midday, the travel to be commenced again in the afternoon. Thus, if the march is begun at seven A.M., it will end at eleven, to be recommenced at two P.M., and ending at six. This will enable the command to make fifteen miles a day, and for a few days this may be continued without fatigue. As far as possible, straggling must be prevented by the company officers, and whenever it is considerable, the column ought to be halted until the stragglers have been brought up. If this is not done, those who have once fallen behind are never able to obtain any rest, since they will scarcely overtake the column before it begins again to move.

We are aware that in moving large bodies of troops it is generally impossible to enforce these rules, except in the case of the few first regiments; the remaining portions of the command, and especially the rear, being compelled to

follow the movements of those who are in advance. In consequence of the frequent interruptions occasioned by the condition of the roads, the breaking down of wagons, the stalling of horses, etc., the intervals of repose soon become exceedingly irregular. The rules which we have given, therefore, in respect to marching, have only a limited application.

During the midday rest, and while dinner is preparing, each soldier who is unemployed would do well to take off his shoes and socks, and if water is abundant, wash his feet so as to remove the acrid perspiration and dirt. He ought especially to wash between his toes, and by this means he will do much towards the prevention of excoriations and soft corns. In no case ought this to be done, however, unless sufficient time is to be allowed after the feet are washed for the cuticle to become again thoroughly dry and hard. When the cuticle is softened by soaking, blisters are much more apt to form. For the same reason the feet may be occasionally dry-wiped to remove the perspiration; and, unless it is absolutely necessary, the troops should not be required to wade through streams or pools of water. In this matter it has happened to us to have some personal experience. Having been taken prisoner at Laverne, Tenn., on the 10th of April, 1863, we were hurried on foot about twenty-five or thirty miles in less than twenty-four hours. During the entire march we suffered no special inconvenience until, when within about eight or ten miles of our destination, we had the indiscretion to bathe our feet in a cool, running stream, and to resume the march without having made them thoroughly dry. In a very few minutes both feet were blistered under the balls, and further progression on foot became almost impossible.

It is sometimes advantageous to change the socks from

one foot to the other, so that their seams or folds shall press upon new points, or to turn them inside out and rub a piece of tallow candle over the inside of the sole; this hardens the cuticle, and diminishes the friction. Hard soap, used more frequently by the soldiers, is liable to the objection that, uniting with the perspiration, it tends to soften the cuticle.

Soldiers who have not been much accustomed to marching—and this is the case with nearly all new recruits—are very apt to have excoriations upon the back and sides of the heels, upon the malleoli, upon the insteps, and upon the knuckles of the toes. The only suitable application, in case the soldier must continue to march, is a broad and pretty long piece of adhesive plaster, with which the raw or tender surface may be completely covered.

It is unnecessary to say that the soldier's clothing must be suited to the climate and season, and that he should carry as little weight about his person as possible. The English troops carry, on an average, including knapsack, haversack, cartridges, and firelock, between fifty and sixty pounds. In the American Army we have found the average about the same; and with the blanket, overcoat, and *tente d'abri*, it has occasionally considerably exceeded sixty pounds. It ought, if possible, to be reduced to an average of forty pounds. The knapsack ought never to weigh over seventeen pounds; and it is worthy of remark, that with one extra shirt and one extra pair of socks, the soldier's wardrobe is more generally found clean than when he is supplied with a greater number of changes. If he has but one extra shirt he loses no opportunity to make it clean; if he has two he neglects to avail himself of the best chances for washing and drying.

The knapsack should be "slung," and not strapped

tightly to the back, for it is better that it should "roll" a little, than that it should restrict the free motions of the arms. The breast-strap should never be buckled, except when the shoulder-straps begin to gall the armpits; it always impedes somewhat the action of the muscles of respiration, and in long or rapid marches it becomes a serious inconvenience. The chest should, as far as possible, be left free for expansion, but the muscles of the loins are supported and invigorated by being well girt about with a broad and firm band.

Indians walk with their toes directly in front of the heel, and experience shows that a man walks faster and longer with his feet in this position than with the toes turned out. The "toeing in," as it is called, enables the person to avail himself most completely of the action of the muscles of the leg and foot. Unencumbered with weight, a man walks easier with his trunk erect, and set square over his haunches; but with a knapsack and gun, it is better to incline a little forwards, especially in rapid progression.

The length of the military step in the British line is thirty inches, but this is suited only to men of full stature, say five feet eight inches, or six feet; nor is it suited to marching *en route*. In the American service the rule is twenty-eight inches for common and quick, and thirty-three for double-quick time. From twenty-three to twenty-six inches will be found the most convenient for most men in the "route step."

To avoid excessive thirst, a full draught of cold water should be taken before starting, and then the mouth should be kept closed during the march as much as possible. The Arabs keep their mouths covered with a cloth. Holding a smooth pebble in the mouth, or chewing a green leaf, will alleviate the thirst somewhat. Simply moistening the

mouth occasionally with water is better than drinking often or freely.

If the water is muddy it may be filtered through a sponge, or a cloth of any kind; or by rolling a handful of grass in the form of a cone, and having dipped it into the pool, allowing it to drip from one end. When a greater supply is needed, it may be obtained in the following manner: a number of holes may be bored in a cask, and having removed the bottom from another and smaller cask, it is to be placed inside the first; fill in the space between the two with grass, hay, straw, moss, tow, wool, sponge, charcoal, sand, or pebbles, and then sink it into the water. A stout canvas bag, kept open by a hoop, and sunk by the weight of a stone, will answer tolerably well. If the water is simply turbid, alum will settle it very quickly, leaving no taste of alum in the water: a teaspoonful is sufficient to render clear a pailful of turbid water. Galton says this plan is adopted very generally in India. A piece of alum merely moved about in a vessel of water will accomplish the same purpose.

Putrid water, filled with vegetable matter and animalcules, ought to be boiled, with a little charcoal in the vessel, before drinking, if possible. "The Indians," says Galton, "plunge hot iron into putrid and muddy water." As the scum rises to the surface it should be removed.

Water can be kept tolerably cool by inclosing the can or bottle in which it is carried, in a wet cloth, and allowing it to evaporate. Leather being slightly porous, and allowing a little of the water to evaporate slowly from its surface, keeps the contents more cool than gutta-percha, india-rubber, or metal.

A little vinegar, or lemon juice, added to the water to

give it a relish, is better than brandy, and it is much more likely to allay thirst; yet, if used too freely, it may occasion a colic or a diarrhœa.

Our soldiers have generally been supplied with tin cans covered with firm, porous cloth; and in many cases these cans are furnished with stoppers into which are fitted pieces of pumice, sponge, tow, and charcoal, or some other porous material, through which the water is drawn in a tolerable degree of purity.

It is the duty of the surgeon always to see before a march is commenced that the water-casks attached to the ambulances are in order, and that they are filled.

The amount of the rations should be considerably increased when men are upon a march, or in active duty; and they ought to have at least three meals per day, two of which should be substantial, and composed in a great measure of meat. Christison has shown that a man in sedentary life requires only about seventeen ounces per day of real nutriment, but that when actively employed, in rough work, he demands from twenty-eight to thirty ounces, or even more. Of course the most compact and nutritious aliments are those which should be selected.

We do not think it safe ever to trust soldiers with opium, morphine, or medicines of any kind, since there are more chances that they will use them injudiciously than at proper times or in proper quantities.

For many other matters relating to the comfort and health of the soldier upon the march, we will refer the reader to the chapter on Hygiene.

CHAPTER VIII.

CONVEYANCE OF SICK AND WOUNDED SOLDIERS.

For the purpose of conveying wounded soldiers from the field of battle to the several depôts where the regimental hospital corps are assembled, as well as for the purpose of transporting them upon marches, or from one depôt or hospital to another, various kinds of conveyance have been employed—namely, those which are borne by men, called "hand-litters," "sedans," or "stretchers;" mules or horses with panniers—*cacolets*—wheel-carriages requiring the aid of horses, mules, or bullocks; railroad cars and transports.

(It may be worth while, also, to mention the mode of conveyance occasionally adopted by two men by forming a "basket" with their two hands. The man on the right seizes his own left wrist with his right hand, the palms being directed downwards; with his left hand he seizes the right wrist of the man on the left; the man on the left seizes his own left wrist with his right hand, both palms being directed downwards, and with his left hand he lays hold of the right wrist of the right-hand man. The wounded man is placed upon this basket while it is lowered to the ground, his arms being placed around the necks of the bearers, and each bearer facing to the front, but a little towards his fellow, moves off with the left foot first.)

Section I.—"Hand-Litters." General Jackson recommended, and adopted occasionally, a very simple method of conveying the sick, in his expeditions against the Indians,

viz. to suspend a bull's hide between two muskets, upon which the patient was carried by two or four men, as the case might require. Soldiers' blankets might serve the same purpose, in case of necessity, especially if they were made with strong loops upon the opposite margins; in which case they might be doubled upon themselves, so that all the loops should be upon the same margin. Through these loops a gun might then be thrust, and another gun through the doubling. Two men may also tie the corners of a blanket about their necks, and carry a man between them; the two men joining right and left hands and walking a little apart. For this purpose the blanket needs to be wider than those in common use among soldiers.

Dr. George Suckley, U.S.V., says that he has occasionally, in frontier service, constructed a temporary litter of two poles cut from the forest; these being laid upon the edges of a blanket, rolled in, and finally made fast with strong twine, by puncturing the blanket at intervals of a foot along the sides of the poles, and tying the twine strongly on the outside.

A very simple and ingenious method of conveyance is to make use of the soldier's overcoat as a sacking. The sleeves being turned inside out, and a musket thrust through each sleeve, the wounded man is laid upon the coat and it is then buttoned together in front. Two men standing between the ends of the guns may now lift him easily; but the conveyance will be made more secure by detaching the leather slings from the guns and passing them under the body, or if they are unnecessary here, they may be employed to cross over the shoulders of the carriers. Canvas may be substituted for the overcoat, guns being used for poles, as we learn from Retzius, is the practice sometimes in the Swedish army.

FIG. 23.

HAND-LITTER, MADE WITH GUNS. (From Galton.)

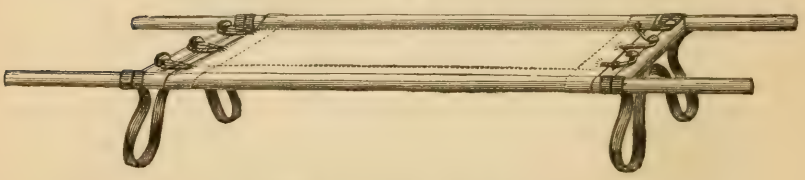
To all of these methods there exists the serious objection that they have no "traverses" or "stretchers" to prevent the bottom from sinking down, while at the same time the guns or poles are pressed uncomfortably against the hips of the bearers.

Ballingall thinks that Dr. Millingen has suggested the "most simple, efficient, and practicable" contrivance for the conveyance of the wounded which has yet been devised. It consists of two parallel poles, separated by two traverses or stretchers, with short legs, and supporting a canvas bottom. The poles of these litters, when not employed for this purpose, and armed with pikeheads, form weapons of offence and defence to the men of the hospital corps when escorting wounded or guarding hospital stores or provisions. Each individual of this corps should be armed with one of these pikes, furnished with one of the traverses strapped upon his knapsack, and one of the canvas bottoms girted round his waist; and any two of them meeting together,

will be enabled in a few minutes to equip a light and efficient litter, capable of carrying off a wounded man with all the comfort of which his situation admits: his pack being placed under his head as a pillow, and his firelock slung from the side of the bearer by means of loops attached to it for this purpose. Dr. Millingen also proposes that each transporter should be furnished with sling-belts, by which the litter will be slung from the shoulders and more easily carried.

The hand-litters employed in the United States Army are

FIG. 24.



UNITED STATES ARMY HAND-LITTER.

composed of two light but strong poles made of ash, each eight feet ten inches long, and one inch and three quarters in diameter, with cross-pieces six feet apart and twenty-nine inches in length, to keep the poles from falling together; across this frame is stretched a firm canvas, made fast at either end by loops hitched to pins on the cross-pieces. The whole can be easily separated, and rolled into a compact form for transportation.

Recently the army has been supplied with a lighter and less expensive form of hand-litters, made with legs which are attached to the side poles by hinges in order that they may be raised or dropped at pleasure, the cross-pieces being made of iron, and joined in the centre by a free bolt, which permits the litter to be closed by bringing the side poles together for convenience in transportation.

We have recommended and practised the construction on the field of temporary litters, made of small trees, or saplings and blankets. Cedar, which abounds in the Southern forests, we have found the best, being light, elastic, and strong; next to these we have preferred pine or ash. Two cross-bars are sufficient. The blanket may be rolled in before the cross-bars are made fast—or, the cross-bars being first secured, the blanket may be "knotted up" by strings, and, if strings cannot otherwise be procured, they may be made by tearing strips from the margin of the blanket.

Oat or corn sacks will serve as a canvas bottom to a temporary litter—or, in an emergency, any old pieces of cloth—the fragment of a tent, an overcoat, or even a pair of pantaloons; some of which things can almost always be found on a battle-field.

Litters—thus constructed—make excellent beds also in a hospital tent, when placed upon four crotched sticks driven into the ground.

Says Galton in his "Art of Travel:" "If a man be wounded or sick, and has to be carried along upon the shoulders of others, make a stretcher for him in the Indian fashion; that is to say, cut two stout poles, each eight feet long, to make its two sides, and three other cross-bars of two and a half feet each, to be lashed to them. Then supporting this ladder-shaped framework over the sick man as he lies in his blanket, knot the blanket well to it; and so carry him off, palanquin-fashion.

"One cross-bar will be just behind his head, another in front of his feet; the middle one will cross his stomach, and keep him from falling out; and there will remain two stout handles for the carriers to lay hold of.

"American Indians carry their wounded companions by

FIG. 25.

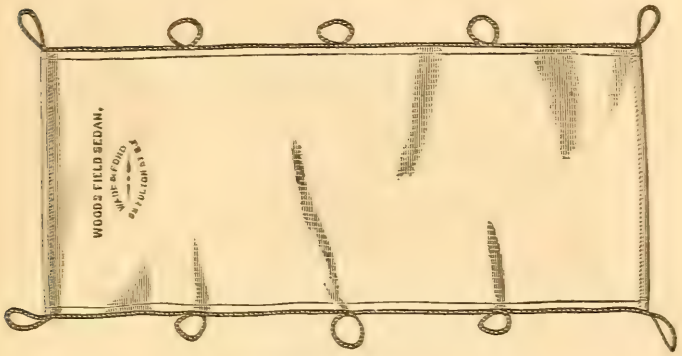
INDIAN HAND LITTER. (From Galton.)

this contrivance after a fight, and in a hurried retreat, for wonderful distances. A kind of wagon-top can easily be made to it with bent boughs and one spare blanket."

Dr. James R. Wood, of this city, has invented a very ingenious hand-litter. The poles being passed through loops on the side of the canvas, and the stretchers, or cross-bars, being made of steel, it can be very quickly rigged and unrigged, and can be rolled up into a very compact form for transportation.

In conveying a wounded or sick man upon a hand-litter, the leading bearer must step off with the left foot, and the rear bearer with the right; and when the bearers become fatigued, the relief-bearers, without setting down the litter, take their places in the following manner: they place themselves, respectively, directly in front and in rear of the two bearers; the relief-bearer in front, with his back to the litter, seizes with his right hand the right arm of the litter, and immediately the bearer releases his hold with

FIG. 26.

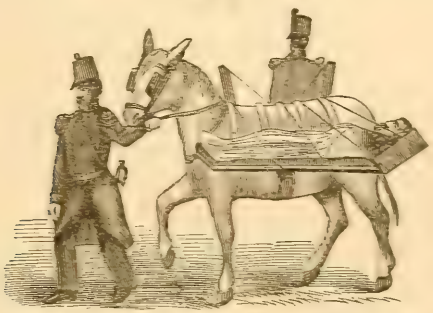


WOOD'S HAND-LITTER.

his right hand and turns out of his place, still holding the left arm of the litter with his left hand; the relief-bearer now seizes the left arm of the litter with his left hand, and the bearer at once lets go of the litter entirely. The bearer, and relief-bearer in the rear, perform the same manœuvre, but with the face of the relief-bearer directed towards the litter.

SECTION II.—PANNIERS. In making long marches through a country where wheels are inadmissible, horses

FIG. 27.



HORSE OR MULE PANNIER. (From Ballingall.)

are occasionally put into requisition to convey the sick and wounded.

In the French service mules are employed for this purpose, fitted with panniers, one on each side of the animal.

One of these panniers, or cacolets, as they are usually called by the French, is intended to convey a soldier extended at length lying upon his back, and the opposite pannier is constructed so as to receive a man in the sitting posture.

Just before the battle of Fair Oaks, eight were sent to us for the use of the 4th Corps. They were only employed, however, on the first day of the battle. The horses were found to be impatient and restless under them, and six of the eight were soon broken, and rendered unfit for use.

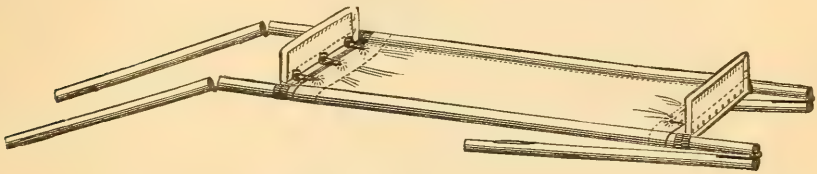
Mules are better than horses for this purpose; they are not so high, and are less restive under the pressure of heavy weights upon their backs; but even mules require to be trained especially to this kind of service before they can be rendered useful or safe.

Baron Larrey describes, in the first volume of his Memoirs, a mode of conveyance for the sick adopted occasionally by the French army in Egypt, upon the backs of camels. "It consists of two large boxes or camel-trunks, fitted up as litters for the reception of the wounded, and slung, on each side of the animal, over a pack-saddle. The camel is made to kneel, as in other cases, to receive his load, and thus the sick may easily be placed in such a conveyance."

Section III.—Horse-Litters. The Army Medical Board decided in January, 1860, "that horse-litters be prepared and furnished to posts where they may be required for service on ground not admitting the employment of

two-wheeled carriages; said litters to be composed of a canvas-bed similar to the present stretcher, and of two poles, each sixteen feet long, to be made in sections with head and foot pieces constructed to act as stretchers to keep the poles asunder."

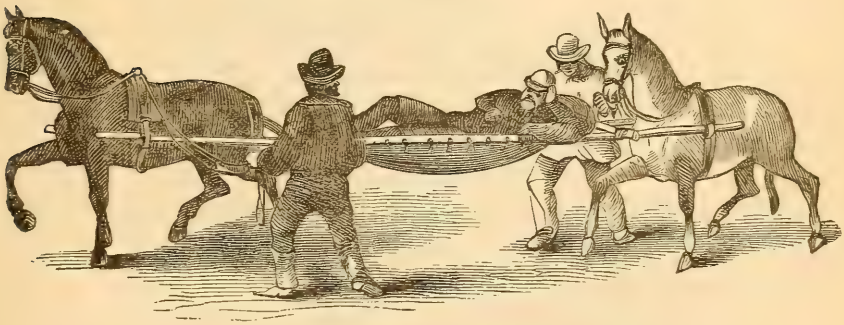
FIG. 28.



U.S.A. HORSE-LITTER.

The side poles are of ash, two and a half inches in diameter. The head and foot pieces are of canvas, stretched over strong iron wire, and are each nine inches in height. Width of canvas, twenty-seven inches; length, five feet ten inches.

FIG. 29.



INDIAN HORSE OR MULE-LITTER. (From the Prairie Trav.)

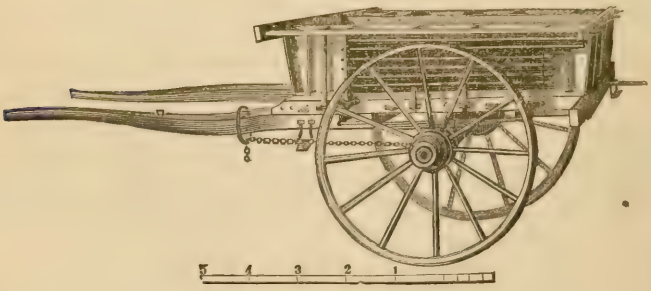
SECTION IV.—WHEELED AMBULANCES. Where wheeled conveyances were necessary, the English and Americans have, until within a few years, employed common spring

wagons; but their inconvenience has at length led to the construction of others more suitable for the conveyance of the sick and wounded.

Of the various plans, Ballingall thinks that the carriage invented by Mr. Cherry is by far the most ingenious which he has seen. It is intended as a "hospital and commissariat" transport at the same time; and since the wounded need generally to be carried in a direction opposite to that in which the provisions, forage, etc., are to be carried, this may convey the latter to the army and bring back the former.

"It is a light single-horse cart, so constructed as to be readily adapted either to the carriage of stores and provisions, or to the conveyance of wounded men; for these two different purposes a great part of the frame-work is movable and capable of being adapted to the object

FIG. 80.

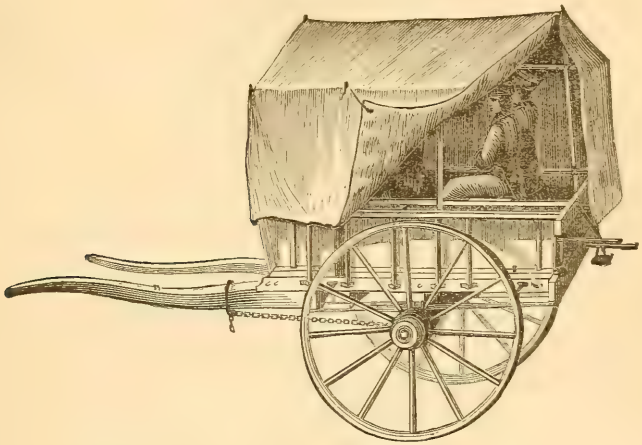


CHERRY'S CART AS A TRANSPORT.

required. In the state here represented, this carriage is adapted to the conveyance of provisions; and it will be observed that a number of movable spars or poles are stowed on the outside of the cart, which may in a few minutes be unpacked and placed upright round the frame-

work, adapting it to the carriage of bulky articles of forage, such as hay or straw. Some of these spars, again, are fitted to be placed as ridge-poles on the top of the uprights,

Fig. 31.



CHERRY'S CART AS AN AMBULANCE.

for the purpose of supporting a canopy for the protection of the sick or wounded. It now becomes a most commodious sick-cart, capable of conveying one person lying at length on a board within, or four men sitting erect on seats, which are suspended from a rope running round the interior of the cart, and giving the advantage of its elasticity in addition to the springs. The seats, when not used for this purpose, form a movable part of the bottom of the cart, under which are boxes for containing the bearer and canopy when not wanted for their respective purposes. The most ingenious part of the contrivance is that by which the ordinary springs of a cart or other carriage may be protected from injury when carrying heavy loads, while at the same time it admits of their free use when light

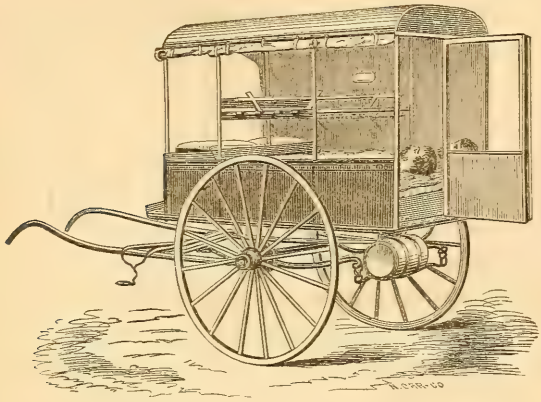
loads are carried. This is effected by two movable blocks sliding along the axle tree; and which, by means of a lever connected with them, may either be moved outwards under the frame-work of the cart, so as to make its weight bear directly on the axle without injury to the springs, or, by turning the lever in an opposite direction, the blocks may be withdrawn from under the side-pieces of the cart into the hollow space formed by their thickness, and the springs thus again brought into action."

In 1860 the United States Army Medical Board recommended the construction of two-wheeled ambulances upon plans furnished by Surgeon Finley; and of an additional number of two-wheeled ambulances after plans furnished by Assistant-Surgeon Coolidge. They also recommended the construction of four-wheeled ambulances after patterns furnished by Surgeon Tripler.

The plan invented by Surgeon Finley, late Surgeon-General, and for which *he applied for a patent*, we have never seen in use. We trust that no Medical Officer in the United States Army will ever set a similar example; and especially that the liberal public sentiment of our profession, and of the Army Medical Officers, may never again be offended by seeing a Surgeon-General hold a patent for an invention designed for the relief of sick and wounded soldiers.

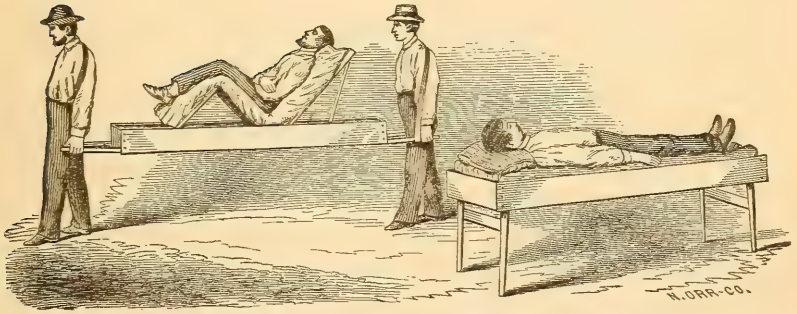
Surgeon Coolidge's (now Medical Inspector U.S.A.) two-wheeled ambulance was very extensively used in the first two years of the war, but it was found too light and the body too movable, for the rough roads in which most of our campaigning was carried on. It is, however, an excellent ambulance for smooth roads, and is still retained in certain portions of the army. The two following wood-cuts will sufficiently explain its construction and mode of use.

FIG. 32.



U. S. A. TWO-WHEELED AMBULANCE,
Designed by R. H. Coolidge, Surgeon U.S.A.

FIG. 33.



COOLIDGE'S MATTRESSES REMOVED FROM THE AMBULANCE.
The two figures represent the same mattress or stretcher in different positions.

Surgeon Tripler's four-wheeled ambulance, requiring four horses, has also been found very serviceable, and is still continued in use.

Within the last year we have had constructed, by order of the Surgeon-General, four-wheeled ambulances, to be drawn by two horses, and intended to carry ten or twelve

persons sitting, or two sitting, and two or three lying down. These have now come into very general use, and are considered as, on the whole, superior to any which have hitherto been made.

SECTION V.—RAILROAD CARS, OR AMBULANCES. The transportation of sick and wounded by railroads has been adopted in all cases in which it was practicable, as being more rapid than any other mode of conveyance, and quite as easy to the patients as the transportation by boats. In most cases, ordinary railroad cars have been used for this purpose, sometimes fitted up with rude bunks; and in other instances, where the means of transportation have been scarce, freight and baggage cars have been made clean, and the floors covered over with straw, upon which the men have been laid.

The U. S. Sanitary Commission have, however, during the past year or two, had constructed a number of very complete and elegant "hospital cars," according to a pattern furnished by Elisha Harris, M.D., one of the members of the Commission. Five of these are running daily between Marietta, Georgia, and Louisville, Ky., a distance of nearly 500 miles; and about the same number are running between Washington and New York and Boston. Others are now being constructed.

About 75,000 sick and wounded soldiers have been sent North by rail during the three first years of the war, and of these a large proportion have been sent in the hospital cars.

The stretchers are suspended upon loops made of gutta-percha; they are so rigged that they may be taken out and the patients borne upon them to their homes, or to the General Hospitals.

Fig. 81.

Fig. 1

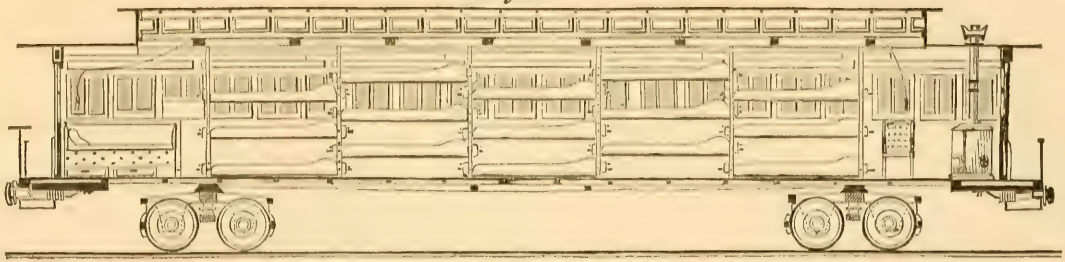


Fig 2.A

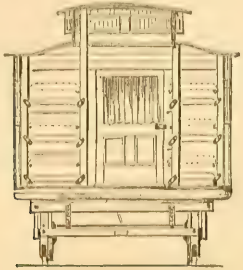
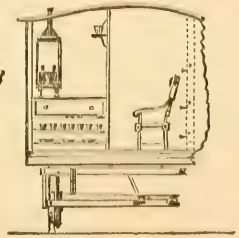


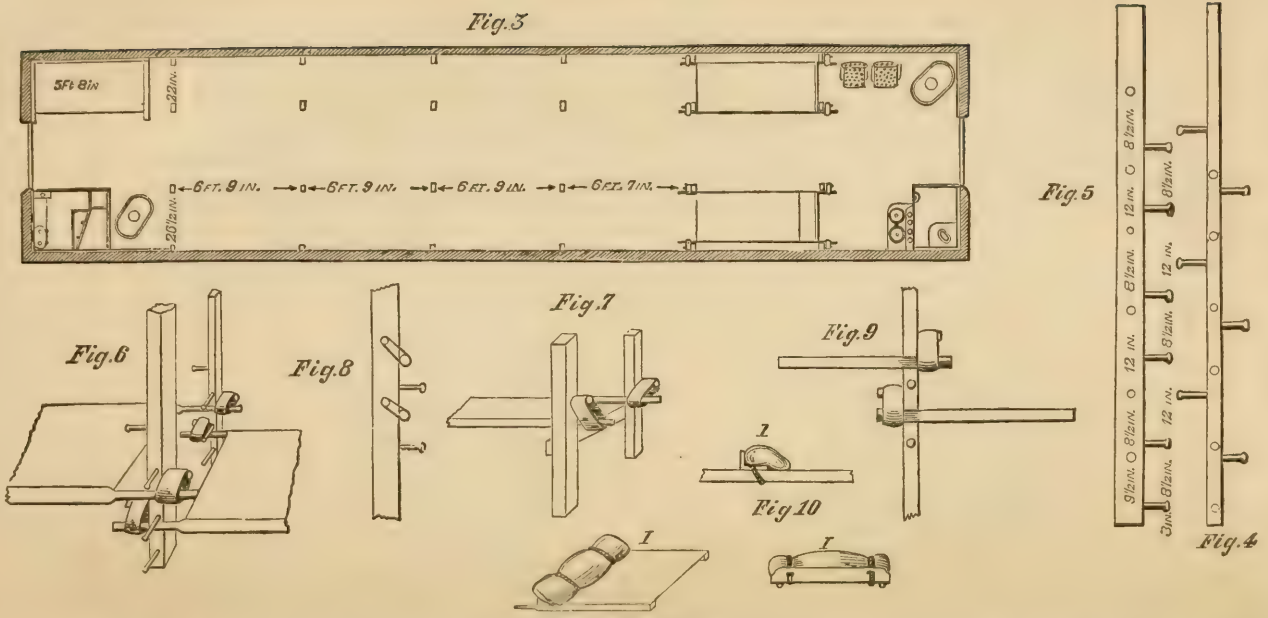
Fig 2.B



U. S. RAILWAY AMBULANCE.

Fig. 1. Longitudinal Section. Fig. 2. A.B. Transverse Sections.

FIG. 35.



U. S. RAILWAY AMBULANCE.

FIG. 3. Plain view. FIG. 4. Front view of Stanchion-pins. FIG. 5. Side view of Stanchion-pins. FIG. 6. Method of Coupling. FIG. 7. Free Method of Coupling. FIG. 8. Side view of Coupling. FIG. 9. Face view of Coupling. FIG. 10. I. I. I. Pillow.

Each car is furnished with a dispensary and kitchen; and every train has a competent supply of nurses and surgeons.

The following remarks of Dr. Perin, Medical Director of the Army of the Cumberland, in relation to the value of these cars, are copied from the Monthly Bulletin of the Sanitary Commission: "I regard them as one of the greatest blessings conferred upon the army; they have done more to save life, to assuage pain, than one-half of my surgeons could have done. Could we have had hospital trains immediately after the battle of Chickamauga, we could have saved hundreds of lives." [The enemy held the railway below Chattanooga at that period.] "Here at Chattanooga our hospitals were totally inadequate; we had to pack wounded about from room to room; the ventilation was abominable; we had no food such as they required. It was beyond human skill under such circumstances to save them, and they died; died, sirs, by the hundreds, simply because we had no means by which we could remove them speedily and easily to Nashville, where special proper care would have saved them."

Section VI.—Transports. In our experience the transports employed by the government, although in general tolerably well suited for the purposes for which they have been used, have been too often over-crowded and ill-ventilated; and they have proved the fruitful sources of fever, hospital gangrene, and pyæmia. In barges, ferry-boats, propellers, and side-wheel steamers, our wounded and sick men have been crowded upon decks and between decks until there was scarcely room for the attendants to move among them. In this manner they have pursued their toilsome way along the courses of our great rivers, the Mississippi, the Mis-

souri, the Tennessee, the Cumberland, and the Ohio; or they have made their way by the Atlantic from our extreme Southern coasts to the North; and, in very many instances, those who have not perished by the way have arrived feeble and exhausted by the journey. To some extent, in a war of such magnitude, carried on over such a vast extent of territory, these evils are unavoidable; and we think our wounded soldiers have reasons to be grateful to the general government for the unparalleled liberality with which its money has been expended for their relief; yet we do not hesitate to say that, rather than crowd the transports to the extent which has been frequently practised, it would be far better to leave the men in an inclement climate, and where fewer comforts could reach them. In our opinion, also, the government ought, as a matter of economy as well as of humanity, to order the construction of a certain number of vessels, for both sea and river navigation, especially designed as hospital vessels, combining all the requisites for ventilation and purification which the experience of other nations and modern science have proven to be useful.

CHAPTER IX.

GUNSHOT WOUNDS.

SECTION I.—GENERAL REMARKS. Gunshot wounds are produced by a great variety of missiles, such as small shot, bullets, shrapnel, grape or canister, chain or bar-shot, shells, slugs, etc.; and to these may be properly added the injuries inflicted occasionally by the powder itself, by fragments of stone or of wood, and by portions of the body of some other person who may chance to have been interposed in the range of fire. These are all projected by the elastic power of gunpowder, and strike the body with great force, unless they are nearly spent. In their course from the weapon to their destination they describe a parabola; and smooth round balls, especially when the speed of their progress has been considerably diminished, revolve constantly upon their own axes. It follows from these two latter circumstances that a nearly spent round ball will be easily diverted from its direct course. Hence those singular wounds in which a ball, having entered at one point of the body, is found exactly opposite, yet it has not passed through but has made a circuit, leaving the contained viscera unharmed; or in which the ball has performed the entire circuit and appears at the very point at which it entered.

Hennen relates the case of a man in whom the ball, which struck the pomum Adami, was found lying in the orifice of its entrance, having gone completely around the neck. A similar case is reported by Prof. Malle in the 28th vol. of the American Journal of Medical Science.

The works on Military Surgery written during the last century abound with examples of this kind, but since the general introduction of the conical ball such cases are more rare. In the early part of the present war the round ball was a good deal used, and especially by the Confederates; but after the first year the conical ball came into almost universal use by both parties; the only exceptions which we have noticed lately being in the cavalry, who frequently use in their carbines a cartridge composed of one small bullet and three to five buckshot, which they call "ball and buck." Occasionally also the infantry, when the conical balls have not been supplied, have been compelled to use the same cartridges.

But whichever form of ball has been used, it has not happened to us to see many examples of very great eccentricity in the course of the missile, nearly all of them having passed out of the body in the same line in which they have entered; or, if found within the body, they have seldom deviated much from their original direction. Of course the most numerous examples of eccentricity have been where the round ball has been employed, and when the force of the ball has been nearly expended. Some of these we shall take occasion to mention when speaking of gunshot injuries of particular portions of the body.

The conical ball goes usually straight to its destination, neither being turned aside by the skin, the flesh, the tendons, fascia, nor even by the bone itself; and if it has not passed entirely through, it is generally found immediately under the skin at a point directly opposite its point of entrance, or rather, we ought to say, directly in the line which it was travelling when it struck the body. The frequency with which the ball, and especially the conical ball, is found resting immediately under the skin upon the oppo-

site side is worthy of remark, since a knowledge of this fact will lead the surgeon to search for it here rather than to explore the track of the wound. This remark holds true not only in wounds of the extremities, but also in very many wounds of the chest and abdomen; and in the case of the head it is observed that when a ball has fairly entered the skull, if it has not passed out again, it is most often found resting against the inner side of the skull opposite the point of entrance. The explanation of these facts is very simple. The skin is tough and elastic, and a missile which has force enough to penetrate it upon one side, has usually sufficient force to traverse the subjacent tissues, while it may not be capable of penetrating again the skin upon the opposite side.

Sometimes the point where the ball lies is plainly enough indicated by a slight reddish discoloration, occasioned by its having stretched the skin nearly to bursting, and then having yielded to the superior power of resistance in the latter. Generally, however, it can only be discovered by passing the hand or the fingers carefully over the skin, when a hard substance will indicate its presence.

It need scarcely be said that if the ball is found thus situated it should be removed by an incision made at this point, or by a counter-opening, as it is termed, rather than through its point of entrance.

In attempting to remove a ball by incision, the surgeon ought, if practicable, to seize upon it with the thumb and fore-finger of the left hand, and hold upon it firmly until the incision is made and the removal accomplished. Sometimes it is more convenient to entrust this duty to an assistant; unless this precaution is taken the missile is apt to recede into the track of the wound while the incision is being made, or slip off laterally in such a way that it can-

not afterwards be easily found, and it may even become necessary to make a second incision at a new point.

The incision ought to be free, longer in extent by some lines than the apparent size of the missile, for it is larger generally than the sensation imparted to the finger would indicate, and it is seldom that the situation does not allow of this free use of the knife.

When the conical ball is reached, it is in most cases found lying sideways against the skin, so that it has to be removed usually by its short axis; it is also generally more or less battered, flattened, angular, or in some way out of shape; and, drawn tightly through the depressions, and over the angles, are small firm threads of cellular, muscular, and fibrous tissue, which effectually resist all efforts to lift it from its bed, even when it seems to be completely exposed. These must be cut by successive touches of the point of the knife, or by cutting firmly into the lead from end to end, when its removal may be at once effected by the forceps or by the pressure of the fingers. We have often seen a lack of attention to these simple precepts on the field of battle embarrass and delay the surgeon exceedingly; and while the patient has been made to suffer much unnecessary pain, the reputation of the operator has been seriously damaged in the estimation of the bystanders.

The fact that the conical ball, when found under the skin opposite to its point of entrance, usually lies with its long axis parallel to the skin, has been confirmed by many observations; and it furnishes, in our opinion, one explanation of the great destructiveness of these missiles, and also of certain peculiarities in the form of the wounds which they produce.

A ball must be destructive in proportion to its weight and velocity, and in these respects the conical ball now

employed has the advantage of all others. It has been thought, however, that in a great measure the peculiar destructiveness of the conical ball was due to its shape and its rotary motion upon its own axis, or upon its axis of progression. Its conical shape may increase its power of penetration, and assist to explain why on the one hand it is itself not so readily turned aside by the tissues, and on the other hand, why the tissues themselves are seldom thrown off from its surface, but are penetrated at once by its wedge-like extremity, so that it cuts its way alike through skin, strong and polished tendons, elastic arteries, feeble veins, and solid bones. In the shape of the missile also we may find a partial explanation of its power to split and comminute whatever bone it touches; but it furnishes no satisfactory explanation of the fact that the wound of entrance and of exit, indeed that the whole track of the wound through the soft parts, is much larger in proportion to the diameter of the ball than that which is made by the round ball; the differences being such that we seldom fail to recognise by the appearance of the wounds the form of the missile which has been employed. The wound of entrance made by a round ball is usually round, and but little if any larger than the missile; its margin is also, in most cases, a little depressed or inverted, and slightly discolored; while the wound of exit is only a little larger and a little less regular in its form, with its margins in most cases slightly everted. On the other hand the wound of entrance made by a conical ball is usually plainly larger than the diameter of the missile, and its form is much less regular, being frequently oval, sometimes linear or crucial, and indeed presenting a variety of other forms; while its wound of exit is very much larger and still more irregular in its outline. Neither shall we find any sufficient explanation of the great

size and irregularity of these openings in the fact that conical balls revolve upon their long axes while passing to their destination. Conical balls make usually less than one entire rotation in their passage from the breech to the muzzle of the gun, and it is not probable that their rapidity of rotation is changed after their escape; so that in passing through the body of a man they cannot be supposed to make more than one complete rotation at the most, probably not one. It does not seem to us, therefore, that they make these great holes by boring after the manner of an auger, as some have thought.

Recurring to the position in which we find these conical balls when lying under the skin, we find an explanation of the large and irregular openings, and in some degree of the destructiveness of the missile, in the supposition that when the ball strikes the outer surface of the elastic integument it is in most cases immediately tilted, or thrown more or less upon its side, and that it passes through in this manner; or if it is not thus tilted at the first contact, and if we suppose even that it strikes the bone fairly with its conical extremity, still it is probable that a lateral deflection occurs sooner or later in its progress through the tissues, so that it is made at last to approach the opposite integument by its broadside. It is no valid objection to this theory that conical balls penetrate and pass through solid pieces of wood without changing the direction of their axes. In this case the resistance is equal on all sides, but in the case of the passage of the same missile through the body the lateral resistance is unequal, and therefore eminently calculated to disturb its equilibrium and to cause it to tilt.

Having removed the ball by a counter-opening, we ought first of all to examine its surface in order to determine, first, whether any portion has been chipped off and left behind.

In the case of a conical ball, experience shows that this is not often the case; yet it may happen. Nor is the mere examination of the surface of the ball very satisfactory upon this point unless it is found to be quite regular in shape, or very much battered, and plainly of much less than the average weight and size. The negative evidence afforded by the regularity of its surface may be of service in the subsequent management of the case, as it will instruct us not to charge to the presence of a portion of the ball a reluctance on the part of the wound to heal. If we have reasons to believe that a portion has been left in the wound, we may think it necessary to institute a new search; and now we may be assured that what remains has not taken the same route after impinging upon the bone, which was taken by the fragment first found, but that it has been more or less deflected. Second, we should examine the ball more especially with a view to determine whether it has struck the bone; and if so, whether the ball struck fairly upon its end or upon its broadside, or whether it merely glanced upon the side of the bone. A conical ball, which is flattened endwise and is deeply seamed, has probably struck the shaft of some large bone, such as the femur, and has produced extensive comminution; the same inference may be generally made if it is greatly battered and scarred upon one side only; but if there is only a small, smooth, flattened facet upon one side, it is probably the result of a glance-stroke, in consequence of which the bone may be not broken at all, or it may have caused only a simple fracture, with little or no comminution. It must be remembered, however, that in a few instances the ball may have impinged upon some hard substance before entering the body; and this may have been something worn or carried about the person of the wounded man, as a button, the

gun, the sword, a tobacco-box, etc. Not unfrequently also slight marks or scratches, or very small flattened facets, are created by the friction of the ball against the sides of the barrel of the gun from which it has been discharged.

The bullet having been carefully examined, the surgeon should next direct his attention to the wound. If the appearance of the ball or the condition of the limb furnishes evidence that the bone is broken, the forefinger of the right hand should at once be carried into the wound of exit, and in the direction of the bone supposed to be broken, for the purpose of ascertaining whether any loose fragments are lying in the track. Fragments of bone are found only on that side of the bone from which the ball has escaped, and to explore from the opposite side for this purpose is only to inflict unnecessary pain. If such loose fragments are found, they must be at once removed, at least if we propose to attempt to save the limb. Upon this point we shall speak more particularly hereafter, when we take up the consideration of gunshot fractures of the extremities.

Balls which penetrate with little force, and slowly—and to this class belong nearly all of those examples in which the missile has not passed entirely through the body—are most apt to carry with them a portion of the clothing. The surgeon ought, therefore, whenever it is practicable, to examine carefully each article of dress through which the ball has passed before it entered the body, and ascertain, if possible, whether any portion has been actually lost, or whether it is merely a rent or a simple perforation. If he find reasons to suppose that anything more than the bullet has been carried in, then it will be his duty to explore the track both through the orifice of entrance and exit, and this examination also should be made with the finger wherever

it is practicable to do so. Unless it is a solid body for which we are searching, very little information can be obtained by metallic probes; indeed, under almost any circumstances, we prefer the finger as being the most intelligent guide, and as causing, on the whole, as little pain as any other method of exploration.

It cannot be too strongly impressed upon military surgeons that all foreign substances, whether bullets, clothing, or loose splinters of bone, should be found and promptly removed from the merely fleshy portions of the body, if they would give their patients the best chances for recovery, and if they would render their recovery as speedy as possible. We shall not be understood as including in these remarks foreign bodies lying in the large cavities, such as the abdomen, the chest, and the cranium; such examples have laws of their own, which will be considered at the proper time; but we desire to correct an impression which certain rare and fortunate examples, occurring from time to time, have served to convey to the inexperienced—namely, that these things left within the body are not very likely to occasion much inconvenience. Nothing is more common than to find in our hospitals soldiers who have lain many months, waiting for their wounds to heal, in whom a lucky or skilful exploration has detected a ball, a piece of bone, or a few threads of the clothing, upon the removal of which a speedy recovery has followed. It is within the memory of many now living that Lieut.-General Scott was for a long time annoyed by a fistulous discharge from a wound in the shoulder received at the battle of Bridgewater, and which ceased soon after a small piece of cloth had been removed.

Examples do certainly occur in which more harm would come of the prolonged efforts to find the foreign substance

than of permitting it to remain. The surgeon must use in this, as in everything else, a sound discretion; and he can scarcely err if he keeps in mind these several facts: first, that if the ball remains it is almost certain to do mischief, and to require removal at some future time; second, that it is almost always easier to remove it within the first few hours than at any later period, because after a short time the track becomes closed by the tumefaction, and at a later day, when suppuration has taken place, it changes its position and frequently becomes deeply buried under fasciæ or muscles; and then, too, the danger to the patient is greater, in consequence of the increased irritability of the tissues and of the whole system.

Round balls, buck-shot, and other small shot, if not much battered, are the substances which in general cause the least disturbance.

If the ball cannot be found with the finger, then we ought to resort to the gunshot probe.

That which we employ is constructed as follows: two sections of equal length, four to six inches each; one of which is made of steel one-twelfth of an inch in diameter and grooved deeply on one side, so that it may serve also as a grooved director; the groove terminates deep in the blunt end, forming a distinct cul-de-sac. The opposite end of this section is terminated with a female screw one-half of an inch in length. The other section of the probe, made of silver, is only one-fifteenth of an inch in breadth, perfectly round, and with a bulb at one end perforated to convey a seton, while the opposite extremity is terminated by a male screw (in the engraving a female screw has been drawn by mistake). (Fig. 36.)

In addition to these two sections, which compose the instrument, we have supplementary sections which may

be substituted for one of the others. Thus, for example, we attach at pleasure a Nelaton's probe, one end of which is provided also with a male screw. (Fig. 37.)

Fig. 36.

Fig. 37.

THE AUTHOR'S COMPOUND BULLET-PROBE.

In searching for a ball with a probe the surgeon ought first, if possible, to ascertain in what position the limb was when the ball was received, and then place it in the same position. If this is not done, the muscles having changed their relations, will close the channel, and render it perhaps impossible to introduce the probe. If he cannot ascertain this from the patient, then, if the probe does not at once pass in readily, he must continue to change the position of the member until he has determined whether he may not accidentally restore the channel. It is important, also, that the surgeon should know from what direction the ball came; and, in the absence of other sources of information upon this subject, he may sometimes determine the point by examining the clothing to see how the rent in it corresponds with the opening in the flesh; and even the wound itself, as it may be more or less indented or abraded upon the one side or the other, may furnish some light.

Now the probe should be seized lightly in the fingers and allowed to drop into the wound rather than be thrust in violently; by which latter method the surgeon will only make new channels, while if his instrument is really in

Fig. 38.

COMMON BULLET-PROBE.

the right direction it will advance toward the ball almost by its own weight.

The probe of Nelaton is often invaluable in determining whether the foreign body, the presence of which the ordinary silver probe may have discovered, is lead or bone. This instrument is a small ball of unpolished porcelain fastened securely upon the end of a probe. Its size may be conveniently varied from two to four lines in diameter, but the size which we have found most generally useful is about two lines. To keep it from being defaced it should be laid in a small, neatly fitting gutta-percha case. In using it care must be taken that all previous stains are removed from its surface by thorough wiping; it then should be pressed down to the foreign substance, and made to rotate upon it a few times. On withdrawing the probe, the porcelain will of course be soiled with blood, but this can be removed by rinsing it in water without any danger of effacing the marks made by the lead.

For the removal of a ball which lies near the surface, any ordinary forceps, or such as is usually found in a pocket-case, will suffice; but if it lies deep in the flesh it will generally be found necessary to use forceps constructed especially for the purpose.

The forceps found in most of the field-cases are too large, the extremity of the instrument occupying too much space when introduced into a gunshot wound. We prefer very much, for general use, a long, straight, narrow instrument, ta-

pering gradually to the extremity, and which is pretty deeply serrated on the surface, where they come in contact with each other. This will often serve the double purpose of forceps and probe; and while it occupies very little additional room when made to grasp the ball, it is at the same time strong enough to remove balls which are not impacted in the bone.

Fig. 89.

LIGHT BULLET-FORCEPS RECOMMENDED BY THE AUTHOR.

In addition to this a well furnished field-case ought to be supplied with a stronger pair of forceps to be used in the removal of larger masses of iron or of lead, and in the extraction of missiles which are firmly impacted in bone. This should have heavier blades, with an olive-shaped extremity; but in our opinion nothing is gained by constructing the blades with bowls to receive the ball. It will not happen once in twenty trials that, on withdrawing the forceps, the ball will be found lying fairly in its concavity. Practically, then, the bowl is of no use, while it diminishes the strength of the blades. The opposing surfaces should be deeply and transversely serrated; and, to prevent their springing under pressure, the hinge should be nearer the distal extremity of the instrument than in other gunshot forceps.

There is no instrument better adapted to this especial purpose than a pair of common pincers, such as are used

by mechanics for various purposes, and especially where much force is to be employed.

Fig. 40.

STRONG BULLET-FORCEPS RECOMMENDED BY THE AUTHOR.

Fig. 41.

COMMON BULLET-FORCEPS.

Mr. George Tiemann has placed us under great obligations, also, by inventing a pair of forceps (Fig. 42) which is especially convenient for the removal of light, round balls, or, perhaps we may say, of fragments of lead, whatever shape they may assume, but which are worthless for the removal of harder metals. They are so constructed, with teeth set obliquely forwards, like the incisors of a mouse, that they will seize upon a ball and hold it firmly, when they grasp only one-quarter of its circumference.

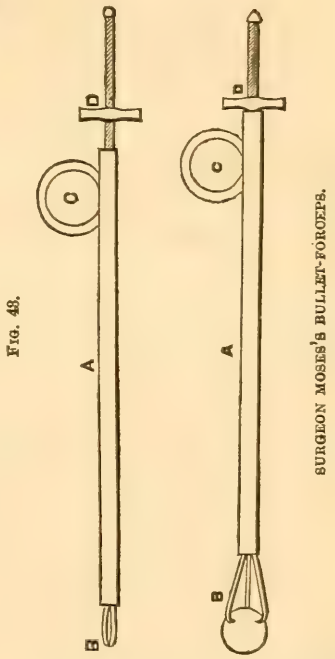
The bullet-forceps invented some years ago by Isaac Moses, Surgeon United States Army, is more complicated, and will not, we think, be found in general use to possess any advantage over our own light forceps or Tiemann's, yet it will no doubt prove a valuable assistant in some cases. It is composed of a silver canula, within which is received a steel rod terminating in three blades, each one of which is completed by a tooth placed obliquely as in Mr. Tiemann's instrument. The canula, holding the blades

partially concealed within its chamber, is carried down to the bullet, when, by the action of a screw, the rod is thrust

Fig. 42.

TIEMANN'S BULLET-FORCEPS.

Fig. 43.



SURGEON MOSES'S BULLET-FORCEPS.

A, Canula. B, Steel blades. C, Finger ring. D, Transverse bar or handle which receives the rod, and by turning which the rod is made to ascend or descend in the canula.

forwards, and the blades expanding are made to seize upon

the bullet by such portion of its circumference as it may touch.

Balls sometimes carry before them the clothing in such a manner as to form a pouch, and they are consequently drawn out of the wound when the clothing is removed. Such examples are pretty frequent. Sometimes it is said, also, that a ball, having struck the bone or some other firm tissue, rebounds through the orifice at which it entered. We are not prepared to deny the truth of this latter statement; indeed we know nothing about it. Patients and surgeons have often offered this explanation of the fact that the ball could not be found; but their statements have never to our mind received a complete verification.

The fact that a ball has been withdrawn by the clothing, can occasionally be established by certain marks upon the clothing at the point where the ball struck, and by the absence of any hole or rent in the same.

If the ball has passed entirely through the body, it is still desirable to know whether portions of the clothing have not been left within the wound; but lest the surgeon should be induced by these remarks to be too officious in such cases, it is proper to say that balls which pass entirely through—in other words, balls which are moving rapidly—seldom leave any clothing in the track of the wound; and it is not often in such cases that we deem it necessary to disturb the wound by much probing. But in case an exploration is made, it must be borne in mind that both the finger and the probe will pass most easily in the direction which the ball has taken, the tissues having been thrown down in this direction as grass falls before the wind. The patient will himself in most cases be able to indicate the direction of the missile; but if he is not, the surgeon may generally make a very correct inference by examining the

wounds of entrance and of exit. As we have before stated, if the wounds are made by a round ball, it will be noticed that the wound of entrance is smaller than the wound of exit. The form of the first is round; its margins are slightly depressed and abraded or contused; while the form of the latter is less regular, and its margins are thrown outwards. These rules have a general application, but admit of a good many exceptions. The size and form of the openings may be reversed, and the wound of exit is now and then found with its margins depressed.

Thus far our remarks have had reference especially to the entrance and extraction of round and conical lead balls, which kind of missiles we have considered first, because the wounds they occasion may be properly regarded as typical of all the others. The peculiarities of other gunshot injuries constitute only deviations from the general laws which govern these. They require, therefore, only a brief separate consideration.

Buckshot, with all the other varieties of smaller shot, do not penetrate with great force unless received at short range, and are consequently seldom fatal. For the same reason, also, they are easily deflected from their direct course, and will often be found scattered in every imaginable direction. Their small size, moreover, and the smoothness and regularity of their surfaces, render them less troublesome when they are permitted to remain. A soldier showed to us a small, hard tumor situated directly over the tuber ischii, which he said was a buckshot received many years before, and which had never occasioned him any inconvenience, although he sat upon it every day.

Harmless as buckshot are generally found to be at a long range, and when they scatter widely from each other, they become exceedingly destructive when they enter the body

at a short range and closely packed together; indeed they are then scarcely less destructive than the conical ball. Fortunately our soldiers are seldom brought into such close action as to expose them to these real dangers of small shot. We think from what we have seen that at the distance of ten yards from the muzzle of the weapon the shot are usually too much separated to inflict a common or single wound.

When buckshot impinge upon a bone they are frequently completely flattened out, forming only thin, round scales, which lie so closely upon, or perhaps slightly imbedded in, the periosteum, that by the most delicate touch, even where the bone is quite superficial, they cannot be detected. This we have especially noticed on the front of the tibia and upon the cranium.

The wounds inflicted by canister and grape do not differ from those inflicted by large, solid shot or shells, when the several balls of which the canister is composed remain together; but when separated, the wound inflicted by a single ball of canister resembles so closely that made by a conical lead ball, that it cannot always be easily distinguished. So far as we know the only point of distinction is that the canister generally makes a larger wound; but we have seen many exceptions to this observation.

Large, solid shot, large fragments of shell, chain and bar-shot, separate limbs instantly, and sometimes with a degree of smoothness which is surprising, the stump presenting now and then an appearance of having been methodically amputated. The muscles, however, when examined at their exposed extremities, will be found contused, dark-colored, motionless, and almost devoid of life. They have not yielded without a struggle, and in their efforts at resist-

ance they have been stretched and lacerated to their very origins, and some of them have been completely torn from their attachments. Nerves also have been violently stretched, communicating extraordinary commotion to the central nervous system; while the arteries, torn completely across, have retracted within their sheaths, and remain hermetically sealed.

Smaller fragments alone are found occasionally buried in the large cavities, or under heavy masses of muscles, and demand sometimes extensive dissections for their removal. We saw at the Camden St. Hospital, in Baltimore, a very singular accident of this sort. Corporal Benjamin Dietzil, of the 49th N. Y. Vols., received the fragment of a shell in the back part of the left hip. This occurred at the battle of Gaines's Hill, on the 27th of June, 1862, and, having fallen into the hands of the enemy, he was soon after taken to Richmond, a distance of ten or fifteen miles. Three weeks after his arrival in Richmond, his attendants first discovered and removed the piece of shell, weighing ten ounces; its dimensions being four inches in length by two inches in breadth. When we saw this patient three months had elapsed, and although no bones had been broken, the wound was not entirely closed.

Occasionally a soldier is found dead on the field upon whose body no mark of a wound, or of a contusion even, can be found, and his comrades have always, in such cases, ascribed his death to the "wind" or "whiff" of a shell or large solid shot; but surgeons very well understand that this is not the true explanation. However large the missile may be, however great its speed, or closely it may approximate the body, unless it actually touches, it cannot cause death, or inflict any serious harm. In the case supposed, the man has been struck, probably, by a large and nearly

spent ball, which may be said to have rolled over him, extinguishing life instantly by the concussion or shock; or it may have been a side glance of one of these huge missiles across the chest or abdomen. Under such circumstances the action of the heart ceases so suddenly that effusions, swellings, and discolorations may not occur, just as we have known death to be caused instantly among pugilists by a "foul blow" upon the pit of the stomach, even though not delivered with great force; and when no mark, either external or internal, has indicated the nature of the injury.

The following case will be easily recognised as an example of death from this cause:

At about one o'clock on the morning of the 31st of July, 1862, while the army of General McClellan was lying upon the banks of the James River, at Harrison's Landing, the batteries of the enemy on the opposite side of the river suddenly opened a terrific fire upon our crowded encampment, and upon the large fleet of vessels lying at this point. Among those who were killed we carefully examined the body of John Booth, private, of the 6th Pa. Cavalry. Upon the right side of his face was a slight abrasion of the skin, but no swelling or discoloration, and this might have been occasioned by the fall. Beyond this he bore no mark of injury, at least upon the external surface of his body. The account of his death given by those who stood near was, that a cannon shot passed first through the neck of a horse in front of him, then struck the ground, ricocheted, and struck Booth as he was standing upon the ground, killing him instantly. Precisely where he was hit we had no means of knowing.

In another case which came under our notice, the explanation of the phenomena caused by the missile was not so

simple. At the battle of Blackburn's Ford, in Virginia, on the 18th of July, 1861, G. Wenzel, a private in the 2d Wisconsin, was kneeling, when, as he affirms, he saw the cannon ball approaching. He instantly threw his head to one side, and at the same moment received a blow which carried away his hat and threw him completely over sideways, so that his face struck the ground. For a short time he could neither see nor hear, yet he did not lose his consciousness. He states also that the same ball carried away both legs of Louis Gardener, a private, who was standing behind him. We saw Wenzel a few hours after the accident, and as he seemed very intelligent, we interrogated and examined him closely. The whole of the right side of his face was red, as if it had been slightly scalded; the upper eyelid of the left side was in the same condition, but the remainder of the left side of his face presented a natural appearance. Over the whole extent of the reddened surface were small, dark-colored petechiæ of a line or two in diameter. His sight and hearing were now perfect. On the 20th we saw him again. The reddened surfaces were now somewhat swollen, and a mild conjunctival inflammation had developed itself in both eyes; the petechiæ had not disappeared, and no other changes had taken place. This was the last we saw of the patient. The only solution of the phenomena which we can offer is, that his cap came between his face and the ball, and inflicted the injuries which we have described.

In the same battle John Hays, a private in the 69th N. Y. Infantry, had his right ear shot away by a cannon ball. We found him, after several hours, at Centreville. He was then inclined to sleep and was not easily aroused, yet he was not actually comatose. The ear was carried away completely, but there was no wound of the scalp,

or evidence of contusion. In this case also it is possible that his cap was partially interposed between the ball and his head.

On the other hand examples without number may be cited in which large cannon shot have carried away an ear, a nose, the lower jaw, or both upper and lower jaws, without leaving any impression upon the system at large. Large portions of flesh have been torn from the back, the sides of the body; the ribs have been broken, or denuded of their skin and flesh; the muscles inclosing the abdomen have been more or less torn away, without causing immediate death, and without inflicting any appreciable injury to the parts adjacent and not actually touched.

Sometimes large portions of flesh are contused by these missiles, but not broken upon the surface; the contusion being accompanied with a loss of sensation in the part, and great swelling, and being followed by rapid sphacelation. At other times broad, dark-colored, and superficial eschars are found, looking as if the surface had been charred by fire. It is very common also for these superficial injuries, caused by cannon shot, to be followed by numbness of an entire limb, or of a large portion of the side of the body.

When the bones of a limb are broken by these solid shots, and the integuments are not torn, the fracture is seldom simple, but almost always the comminution is excessive. This fact will be recognised by grasping the limb firmly, when the sensation will be conveyed of a large number of fragments rubbing upon each other. Under such circumstances amputation, which offers but a feeble chance, is the only resort.

Chain and bar-shot, used occasionally in cannon, and which are especially destructive at short range, we have not seen employed during the present war. They cannot be

thrown with much accuracy, but when they strike a body of men approaching they sweep through like a flail, dividing in two everything with which they come in contact. In a few instances, we have been informed, our enemies have thrown fragments of railroad iron, but they are said to have always fallen so far short of their mark as to have done little or no harm.

It remains to consider the effects of powder, when the separate grains of which it is composed have been driven into the skin. These accidents occur probably more often in civil than in military practice, and are the results usually of the premature explosions of powder in blasting: but occasionally similar accidents are seen in military practice, from the discharge of blank cartridges and in many other ways.

The powder seldom penetrates much deeper than the true skin, and still more rarely beyond the dense fasciæ covering the muscles. It is possible, however, for it to penetrate deeper; and instances occur every now and then in which, entering with the wad, and remaining massed together, it penetrates the tissues deeply, forming a ragged and blackened hole, and even causing death almost immediately by severing some large bloodvessel.

Ordinarily it is found lying within, or just beneath the true skin, where it may be seen as well as felt distinctly. It occasions at once a superficial redness and swelling, but rarely is the irritation caused by the powder sufficient to give rise to much suppuration. If permitted to remain, it produces an indelible stain, which gradually extends from each separate grain of powder a line or more into the adjacent tissues, and thus produces a more complete discoloration of the whole surface.

Its removal is best accomplished as soon as possible after

the injury is received, and before the swelling has closed the orifices of entrance, by the use of a pretty well sharpened probe or pick made of wood, by a goose-quill, or by an instrument of silver or of steel. In order to find the small orifices, the surface ought to be thoroughly washed with warm water and then carefully dried, and the part should be brought into a strong light, or a convex eye-glass may be used. If more time has elapsed, and the orifices are completely closed, each separate grain must be cut upon by the point of a lancet, or by a sharp bistoury. The operation is tedious and sometimes painful, but it will generally well repay for both the labor and the pain. It must not be understood, however, that the removal of the powder, even though it is accomplished very promptly, prevents entirely the discoloration. It diminishes the discoloration very greatly, but we have never seen it altogether prevented.

The subsequent treatment consists simply in the application of cloths wet with cool or tepid water, conjoined perhaps with cathartics and low diet.

When grains of powder have entered the surface of the cornea they cause much irritation, and demand immediate removal; but we have frequently noticed that when the surgeon, from want of tact or of opportunity, failed to extract them, they generally loosened in the course of three or four days by occasioning a superficial ulceration, and fell out of themselves. When they have fairly entered the cornea and lie within the chambers of the eye, if they can be seen they should be removed by an operation similar to that practised for extraction of the lens. When not removed, except in very rare instances, the eye will ultimately be destroyed.

It is much more common to find that a fragment of a

copper cap, or the piece of a fuse employed in discharging cannon, has entered the chambers of the eye. The same remarks apply to these as to particles of powder. If possible, they should be extracted.

SECTION II.—PRIMARY HÆMORRHAGES. Pursuing the natural order of this subject, the next point we have to consider is, the occurrence and treatment of hæmorrhage.

Venous hæmorrhage, as a primary accident, seldom demands especial attention, unless it be in examples of wounds of such large veins as the internal jugular or femoral veins. Smaller veins usually cease to bleed on the first approach of syncope, and their bleeding is not renewed by a restoration of the circulation, except where the peculiar position of the limb or some permanent constriction favors the hæmorrhage. In case of hæmorrhage from the larger veins the prompt and judicious application of compression suffices for its arrest. Hæmorrhage even from the large venous sinuses within the skull may be arrested, where the condition of the wound permits, by small pieces of sponge, or by pledgets of lint sustained by bandages.

Wounds of large veins within the great cavities of the body, and which are beyond the reach of pressure or of the ligature, are as fatal as wounds of large arteries; yet death does not occur quite as speedily.

Primary Arterial Hæmorrhage. It is one peculiar feature of gunshot injuries that, in proportion to the number and severity of the accidents, profuse arterial hæmorrhage is rare. The wounds inflicted by the missiles employed are generally contused and lacerated, seldom incised; and the same general laws as to bleeding, which govern contused and lacerated wounds elsewhere and from other causes, govern here. The arteries being crushed and torn asunder

in a certain number of cases, retract within their cellular sheaths; other tissues are forced in upon them; blood coagulates around them; and they no longer yield to the impulse of the heart, but remain for a time, if not permanently, closed. Several circumstances, however, may modify, in this respect, the effects of contusion and laceration; thus, small vessels are more easily sealed up than large ones; a vessel only partially divided, or wounded upon one side, cannot shorten upon itself and bury its wounded surfaces within its own sheath, and the hæmorrhage will continue; arteries severed by balls which are travelling with great rapidity bleed more freely than when severed by balls which are travelling slowly, the lesion in the first instance approaching more nearly to the character of an incised wound; wounds inflicted by irregularly shaped or angular missiles, produce also in many cases something like incised wounds.

It must be mentioned, also, that round balls, and even conical balls when their force is nearly expended, sometimes pass directly across the track of a large vessel without causing any immediate hæmorrhage, and without breaking any of its coats, the vessel being itself thrown aside. In such cases, however, there is great danger that the vessel has suffered so much contusion that it will eventually slough, giving rise to secondary hæmorrhage.

If a limb is torn completely away from the body, it is no uncommon thing to find that the large vessels have bled but very little. The brachial, anterior tibial, and even the axillary or femoral arteries, are occasionally found under such circumstances completely closed; but it is seldom, we think, when either of these arteries has been divided by a penetrating shot, as by a ball or buckshot, that it ceases to bleed spontaneously. Whether this is because, in the latter

case, the artery is generally only partially divided or not, we cannot say, but certainly the fact is so, and most of these men would bleed to death unless surgery came promptly to their aid. It is an error, then, to suppose that death from hæmorrhage upon the field is very rare; nor is this what we would teach, but only that it is rare as compared to the severity and number of the accidents. We cannot estimate the frequency of death from this cause by the number thus wounded and brought from the field without fatal hæmorrhages. Most of these men die before succor can reach them; and we shall form a more just estimate of their number if we visit the field after the battle has closed and observe how many are lying dead with only a wound in the groin, in the ham, in the arm, or in the axilla. We have seen too many of these examples to be mistaken as to its frequency.

Says the venerable Dr. Valentine Mott, in a most excellent treatise on "Hæmorrhage from Wounds:" "It is true, notwithstanding all that has been done by the very admirable surgical and sanitary departments of our immense army, that many soldiers still perish on the field of battle from hæmorrhage, or are so much reduced as to preclude their subsequent recovery." And after a graphic description of the mode of death by bleeding, he adds: "My heart sinks to think how many of our noble volunteers have passed through these tortures in the dark and chilly night after the battle, with no friend near to aid or even pity them, yet fearlessly and bravely have passed through into the regions of immortality beyond! * * * In the progress of the present war, cases are continually occurring which exemplify too plainly the truth of these remarks. At Antietam two young brothers stood side by side in the ranks of our army, and together bravely

fell, the former by a minié ball through the limbs, and the other wounded in the thigh by a fragment of shell. He who was shot through the limbs still survives to reveal the horrors of the ensuing night, and relate the story of the tragic death of his brother, who was wounded in the thigh, by repeated hæmorrhages from the femoral artery, which the two together were unable to control. When the survivor recounted to me the experience of that fatal night, and told me how his brother bled and fainted and rallied, and bled and fainted and rallied again, his bosom overflowed with grief, and his eyes became suffused with tears. But his bitterest sorrow was because he knew that, with the proper means, he might have arrested the hæmorrhage, and thus given his brother a chance for his life.

"Such instances as these are not isolated, but are continually occurring. * * * * Even as this paper is being prepared, the second officer of one of our vessels of war has fallen a victim to hæmorrhage from the loss of a leg below the knee by a cannon-shot, which hæmorrhage occurred while removing him from the deck to the cabin of the vessel."

To arrest the bleeding from the smaller class of vessels nothing is necessary but to apply a little cold water, or to expose the sufferer as much as possible to the air. Hot water will accomplish this end even more promptly than cold, and it is especially appropriate when the patient is feeble and exhausted by the shock. Elevation of the limb will also contribute to the same result.

Larger vessels demand the ligature, if it can be applied. For this purpose we shall find it necessary, in many cases, to enlarge the wound in the direction of the bleeding vessel; and it is no doubt better, as a general rule, to do

this promptly and freely, rather than to incur the evils of great loss of blood, or of extensive infiltrations into the surrounding tissues. When the artery is found, care should be taken to follow it some distance towards its source before applying the ligature, in order that the latter may be beyond the reach of the sloughing which is likely sooner or later to occur in the course of the wound. If the artery cannot be easily isolated, the surgeon must adopt the next best alternative, and thrust a curved needle armed with a strong ligature freely toward the bleeding vessel, and endeavor to seize the artery with more or less of the surrounding tissues. If it is a large artery, such as the anterior tibial, the femoral, brachial, or axillary, after applying the ligature to the proximal end, the distal end also should be tied; and this should be done even though at the time no blood is escaping from this extremity, and the same care should be employed to apply the ligature as deep within the tissues as possible. If the hæmorrhage is well controlled by a tourniquet during this operation, so that the patient is in no danger from immediate loss of blood, the surgeon ought not to value his time, or to spare any pains in doing this part of his work thoroughly. It is dangerous to trust to a ligature applied in the track of the wound when only the extremity of the artery is tied. These are the cases which give rise to a large proportion of the fatal secondary hæmorrhages; and if, owing to the depth of the wound, or for any other cause, the vessel cannot be tied at least half an inch outside of the track of the ball, it will be much better to cut down and tie the main trunk at some point higher up.

It will be understood that in what has been said we have expressed our decided preference for applying the ligature within the wound whenever, without making extensive

dissections, it can be well done, or when the necessity for prompt action does not render it necessary to resort to a more expeditious method. The grounds for this preference are, first, that by this procedure we have one wound less; and second, that generally, in proportion as we carry the ligature toward the trunk of the body we cut off the lateral and anastomosing branches, and increase the danger of losing the limb from want of arterial circulation; a result which experience shows is apt to occur, when, in addition to the other injuries which the arm may have suffered, the ligature is applied to the subclavian artery, and especially when, under similar circumstances, the ligature is applied high upon the femoral. Moreover, the advocates of the opposite method cannot deny that secondary hæmorrhage is a pretty frequent occurrence when the main trunk is tied remote from the wound.

After all it will be found in practice that a rigid adherence to the rule which we have now laid down will exclude a very considerable number of examples of wounds of the large arteries, especially in many cases where the tibial arteries have suffered lesion anywhere in the middle or upper portions of the leg.

In tying the artery within the wound, if it is at the moment bleeding, the surgeon will be guided to its upper extremity by the bright red color of the blood and by the jet; the blood which flows from the lower orifice is frequently much darker, and seldom escapes in a jet. It happens sometimes, also, that the lower extremity does not bleed at all until the upper portion has been secured, and perhaps not until full reaction has taken place, after which it may be found bleeding *per saltum*, and the blood will probably have resumed its arterial color. If neither artery is bleeding at the moment of the examination the

surgeon must be guided by his anatomical knowledge, aided, in some cases, by an obscure pulsation.

The blood of persons who have been placed under the influence of an anæsthetic is darker than usual, and this change is especially marked in the arterial blood.

The best ligature is stout, compact, and well waxed harness-maker's silk, which is now generally sold by druggists as "surgeon's silk." No other ligature will be found on the whole so uniformly reliable as this. Nothing is more annoying than to break a ligature while tying an artery; and the only way to test its strength is to tie it first upon a probe. Thread which cannot be broken by pulling upon it with the two hands, and without knotting, will often break easily if doubled and drawn tightly over a body of about the size of a closed artery.

Crowding lint, cloth, sponge, or tow into the wound, for the purpose of arresting hæmorrhage, may be very proper on the field, when no other means are at hand; and occasionally, also, it may be justifiable as a temporary expedient, while the surgeon is deciding upon or preparing for other measures, or in case the hæmorrhage, though free, seems to proceed from a number of small vessels, but in no case should it be adopted as a permanent mode of arresting hæmorrhage if it is possible to apply the ligature.

Nor do we ordinarily resort in primary hæmorrhage to such styptics as persulphate or perchloride of iron, since they are not usually required, and they act injuriously upon the tissues to which they are applied. Injecting these articles into the track of a recent wound is especially bad practice, since they seldom fail to give rise to extensive suppuration or sloughing, while they probably never, when thus employed, arrest the bleeding. The use of these agents is reserved for intermediary and secondary

hæmorrhage; but if one sees fit to employ them in primary hæmorrhage the most convenient method will be found to be, to saturate a piece of lint in the solution, and lay it over the bleeding orifice, and then placing above this a larger pledget of dry lint, or a piece of cloth folded, direct an assistant to retain it in place by moderate pressure made with his fingers for a few minutes, or longer, if necessary.

Finally, uniform and moderate pressure with a roller, with or without a compress, will generally close sufficiently all the smaller vessels, and materially diminish the danger of further bleeding from the larger vessels.

No part of the dressing of a gunshot wound has more value when judiciously employed than a roller, and at the same time nothing is capable of doing more harm. If a roller is carefully applied to the limb at an early period much of the bleeding is prevented, and most of the blood which does escape flows out freely from the orifices, which are left open purposely; and thus we are apprised not only of the amount of bleeding, but those extensive intermuscular extravasations are avoided. If, however, the roller is applied too firmly, or unequally, and if it is permitted to remain upon the limb too long, it may do vastly more injury by the strangulation which it occasions, than it can do good. We do not think the roller serviceable except to obviate bleeding and the early serous effusions; consequently it ought not to be continued after inflammation and reaction have fairly set in. This period may vary from twelve to twenty-four hours, and possibly may be extended considerably longer; but, in the meantime, the limb ought to be seen, and its condition carefully noticed at short intervals, and the roller removed or loosened as soon as the limb presents the slightest evidence of strangulation.

It is seldom on the field of battle, according to our

experience, that the surgeon has at hand proper bandages, or can devote the requisite time for their careful application, and in the great majority of cases during the present war they have been omitted. Nor have we generally advised their application, or regretted their omission, because we thought we could very well foresee that these patients were not likely to receive the subsequent attention which such dressings required. It might be many hours, and possibly days, after they had passed from under our notice, before a surgeon would be able again to examine the limbs, and it is never safe to entrust things of this sort to the patients themselves. We have contented ourselves, therefore, with simply applying to the wound a piece of cloth or of lint, wetted with cool water. We would not dare to recommend the general use of rollers on the battle-field, even if we had both time and conveniences, unless it could be rendered absolutely certain that all the other conditions stated would be complied with.

The roller, if employed, should commence at the extremity of the limb and extend some distance above the wound; and if bones are broken in such a way that the limb is unsupported, it should be lifted, moderately extended, and steadied carefully while the roller is being applied; and finally, the broken ends should be rendered less movable, if possible, by side splints of binders' board, which should be retained in place by the same roller.

SECTION III—PRIMARY DRESSING OF GUNSHOT WOUNDS. The primary local treatment of gunshot wounds is at the present day reduced to the most simple formula; which formula may be very fairly expressed in the single word *water*.

Rejecting all the various forms of medication with which

surgeons and empirics have sought at one time or another to improve the medicinal powers of this simple element, we have come at length to understand that pure water alone, skilfully employed, is competent to answer nearly all the indications ordinarily present; and that its skilful employment only implies judicious and timely variations of its temperature.

We infer, therefore, that those who advocate the use of water only at a very low temperature, or the freezing mixtures, as well as those who advocate the use of only warm water, are alike ignorant of its true value as a topical application, since its range of powers is almost equal to the range of its capacity to impart or abstract caloric. We will discuss the medicinal value of water, as connected with its temperature, hereafter.

Since the commencement of the present war the American army surgeons, whether upon the field or in hospitals, have almost uniformly used water as a dressing for recent gunshot wounds. In most cases the water used has been such as was most easily obtained, either river-water, well-water, or water from springs and cisterns. Sometimes the water has been hard and sometimes soft, sometimes muddy or brackish, and sometimes clear; nor have we had occasion to notice any difference in the medicinal effects. The small proportions of foreign matter which they contained were not sufficient to change, or, perhaps, even to modify their properties. It is probable that the results were precisely the same as if pure distilled water had been used. If, however, we were to indicate a preference, we would say, clean rain-water is the best, and simply because theoretically it would seem that it ought to be so.

Nearly all of our surgeons also have used cool water, or water at the temperature of its sources; but we have not

met with any who applied ice or refrigerating mixtures, unless it was in a case of hæmorrhage, or under some very extraordinary circumstances.

The observation just made, that American army surgeons have, during the present war, employed almost universally cool or cold water, requires some words of explanation. It is entirely true that the water has generally been cool when first applied; but it is scarcely necessary to say to those who have observed our hospital and field practice, that in only a very small proportion of the cases have the dressings been moistened sufficiently often to maintain the same low temperature; almost never on the field. It is only by adopting the method by irrigation that a uniform and low temperature can be maintained; and these irrigations have in general only been practised in the hospitals after they have been fully organized, and at a period when the inflammation and other primary accidents of gunshot injuries have existed some time, or perhaps in a measure disappeared. The method employed in most cases has been to wet a piece of cotton cloth or a piece of patent lint with the water, and lay it upon the wound. After which the application has been renewed at the discretion of the patient, or as often as the nurses could attend to it; and this might be once in an hour, or in six hours or more. We imagine that even in private practice and in civil hospitals the application of water by compresses is usually subject to the same criticism. But generally a compress will acquire the temperature of the part to which it is applied in a very few seconds, so that in fact the water is soon warm. Strictly speaking, then, our surgeons have generally treated their wounds in the first instance, and for several days, with warm or tepid water; and whatever results have been obtained are due properly to warm and not to cool

applications. The results have generally been satisfactory, and we accept the testimony as evidence that in general tepid applications are the best. It might be better, therefore, to have the temperature raised at once to near or quite the temperature of the part injured; yet it is not probable that a slight lowering of the temperature by renewal of the cool water as often as it may be necessary in order to keep the dressings moist would do any material harm. There is also sometimes a manifest advantage in the use of the cool water in the first instance, in consequence of its hæmostatic properties; and this may be a sufficient reason why we would not in general desire to have the temperature of the water raised.

No complaints have ever been made against tepid water. No one has ever charged that it produced gangrene, or excessive suppuration even, unless it was continued a long time, and after suppuration had actually commenced; but the same cannot be said of cold water and of ice water. Many surgeons have declared to us that they have seen much mischief done in this way, and we have ourselves seen several conclusive examples.

It is our confident belief that, where the bleeding has wholly ceased, tepid water ought to have the preference as a first application; but that from this point of time, or soon after, the temperature may be gradually and steadily lowered for several days; keeping constantly in mind that our object ought to be, not to extinguish the inflammation, but only to control it, and for this purpose we may, commencing at some time during the first or second day, lower the temperature to 80°, 70°, or even 60° or 50° Fahrenheit, just in proportion as the inflammation increases, and then gradually elevate its temperature as the inflammation declines, or as suppuration intervenes. Usually, however,

it will be best not to make a change of more than 10° or 15°.

Such changes can only be properly made by the method of irrigation.

To these general remarks we shall add some supplementary and perhaps exceptional observations hereafter, especially when we come to speak of the treatment of gunshot wounds during the intermediary period.

In order to employ irrigation effectively it will be necessary first to lay upon the wound a piece of cloth, such as cotton, linen, or woollen; loose woollen or flannel cloth has the advantage of receiving and retaining the moisture most completely; but a piece of patent lint is better than either, since it not only retains the water well, but is soft and unirritating to the skin. This compress ought to be large enough to cover not only the wound but several inches of integument beyond its margins, and it should be made to lie everywhere in contact with the surface. In no other way can we secure a uniform humectation of the skin. After the battles of the Wilderness, in May, 1864, in default of anything else, we used pieces of woollen cloth torn from blankets, coats, and flannel shirts, and these were found to answer very well, especially as they held the water a long time.

The water may be held in a common wooden pail, suspended above the limb, or placed upon a table beside the bed. A hole should be bored in the side of the pail with a gimlet, half an inch above the bottom, and through this a piece of goose quill, of reed, or of a gum elastic catheter, should be thrust of about three inches in length. Through the tube may now be carried a few threads of candle wicking or packthread, just sufficient to fill it, and the outer ends of the wicking may be separated and made to

rest upon several points of the compress. The water, conveyed by capillary attraction, will gradually escape from the pail, and saturate the compress.

A keg of water with a spigot may be used, and the cloth, used as a conductor, may be wound around the spigot.

Other contrivances have been adopted by our surgeons which have answered their purposes very well. In some hospitals we have seen tin fruit-cans perforated at the bottom with a piece of cotton cloth drawn through the opening, and suspended over the wound; sometimes a soldier's canteen has been used, with a hole in the stopper, and then suspended with the mouth down, or a glass bottle or a tin tunnel arranged in the same way. But these require to be replenished very often.

When a pail is used the temperature can be regulated by a thermometer, and it can be so gradually lowered that the changes will scarcely be noticed by the patient. Since in the army such articles have to be economized, it may be well to suggest, that a wooden plug will restore the pail to as good a condition as it was before, and that it is even possible to avoid making a hole in the pail by using the candle-wick or a piece of cloth as a syphon, drawing it over the top of the vessel. Instead of the cloth, we may employ a regular syphon made of tin, glass, or india-rubber, and if the orifice of exit is too large we may close it partially with a piece of sponge.

Sometimes we have seen used a large, straight tin tube suspended horizontally over the limb, which receives the water from the pail, and then distributes it to the various portions of the limb through several small vertical tubes attached to the sides of the horizontal tube. This is the method recommended by Velpeau.

Returning to the matter of temperature, we wish to say that the final decision as to whether we shall in any case employ tepid, cool, cold, or ice-cold applications, must depend upon the sensations of the patient. We shall seldom or never err if we make use of that temperature only which the patient declares most agreeable. Irritation is the first link in the chain of circumstances which results in inflammation, and pain is its subjective sign; we may therefore conclude that those applications which most effectually allay pain, or obviate sensations of burning, smarting, throbbing, &c., will most certainly prevent or subdue irritation and inflammation; and that the opposite of this proposition, namely that whatever increases pain, &c., will increase inflammation, is equally true.

Upon this one point nearly all the surgeons who have used water in the treatment of wounds have arrived at the same conclusion. The majority have preferred tepid water; some have preferred cold, and a few have declared their general preference for ice-water. But however much they have differed in relation to absolute temperature, they have never, so far as we are aware, deviated from the opinion that if the application increases the pain it is actually hurtful. Their views will be found further illustrated and sustained in that excellent treatise entitled "On the Employment of Water in Surgery," written by M. Alphonse Amussat of Paris and published in 1851, and which we translated into English the same year.

When suitable water cannot be obtained, as is sometimes the case at sea, or when patients are being transferred long distances by land, simple cerate, spread upon patent lint, makes the best dressing for recent wounds. In the latter case, also, one can scarcely appreciate the additional comfort which is given by covering the dressings with a broad

and pretty thick compress of cotton batting, tow, or some other soft material, and securing it in place by a few light turns of a roller, or by adhesive plaster. It protects the wound, and the now highly sensitive skin in the vicinity of the wound, from the chafing of the clothes, and from being bruised by contact with the vehicle, and in many other ways.

Sutures are never employed in bullet wounds, and only rarely in lacerated shell wounds. If employed at all, it is only in general as means of partial support, and not for the purpose of securing union by first intention.

Adhesive plasters have also their occasional use, but experience convinces us that they are liable to abuse. Surgeons, in their zeal to have their wounds present a neat and tidy appearance, frequently bind together in this way lacerated wounds with too much firmness, so that the free escape of blood and serum is prevented, and the inflammation of the skin is aggravated by the tension. Occasionally they ought to be employed for the purpose of securing accurate coaptation, but in general only with the view of giving moderate support.

SECTION IV—AFTER TREATMENT OF GUNSHOT WOUNDS. In the progress of the pathological changes which the tissues undergo after the receipt of gunshot wounds, there is usually a period of reaction, with more or less active inflammation; and a period of decline of inflammatory action, accompanied with suppuration and sometimes with other pathological phenomena. These two periods have not been inaptly termed intermediary and secondary.

Intermediary Period.—The hæmorrhage, which has already been noticed as occurring immediately after the receipt of the injury, or in the primary period, having

ceased, may possibly recur when reaction has fully taken place, or at the commencement of the intermediary period. Such hæmorrhages are easily understood. They are the result of returning circulation, and if only moderate, and if proceeding only from small vessels, they will demand no special attention. In a few hours more the steady progress of the inflammation will entirely put an end to such slight oozings of blood. If, however, this bleeding is excessive, or if it proceeds from larger vessels, the surgeon must find promptly some means for its arrest. It may be that the limb is in a depending position, or a bandage may be mal-adjusted and producing ligation: but more often its cause will be found in the fact that the surgeon has omitted to secure some considerable artery; and if change of position, refrigerating mixtures, or well applied pressure, do not speedily succeed in its arrest, no time should be lost in removing the dressings, wiping away the clots, and securing the vessel with a ligature.

These intermediary hæmorrhages are pretty frequent in military practice, and do not often receive the attention they demand. If it were not that surgeons cannot always spare the time when the number of wounded is very great to make a very critical search for vessels which do not at first bleed, we would say that such bleedings implied culpable negligence on their part: but however this may be, the omission to give to it careful and prompt attention now can only be excused on the ground of an extraordinary necessity. Some of these patients, left to themselves, bleed to death; but it more often happens that, in the hope of arresting the bleeding by pressure alone, or by cold applications perhaps, the surgeon intrusts the matter to an attendant, until the track of the wound and the adjacent

structures become filled with coagula, which greatly increase the difficulty of subsequent ligation of the vessel; and which coagula, if the bleeding finally ceases, become depots for the formation of pus, thus greatly retarding the final cure. In the case of amputations made upon the field, the same observations will apply. The intermediary hæmorrhages lift the flaps, and prevent all possibility of immediate union. It is far better in such cases to reopen the wound, remove the clots, and tie the vessels; although it may be somewhat mortifying to the surgeon who made the original dressing, since it is apt to be construed into a reflection upon his skill.

In regard to the water dressings, the rule which has been laid down as applicable in the first instance still holds good, namely, that the temperature be made agreeable to the patient. It will often be found, however, as the inflammation progresses, that the temperature may be gradually lowered; and in a few examples of active inflammation, invading a large amount of soft structure, even the refrigerating mixtures may be employed. It is certain that actively inflamed surfaces tolerate a greater degree of cold than surfaces only slightly inflamed, probably for the reason that caloric is elaborated under these circumstances much more rapidly. Yet it is possible to freeze inflamed tissues, and some care is required to avoid this accident. The ice, snow, or ice-water should not be applied directly to the skin, but always with some non-conductor interposed, such as cloth, lint, or a beef's bladder; the latter, half filled with the cold mixture, constitutes the most convenient mode of application. If after the cold has been applied some time the patient experiences a sense of numbness in the part, a total loss of sensation, or a cold clammy sensation, even though it may not be actually painful, the

water ought at once to be discontinued or its temperature raised. It is our opinion also that in all cases the temperature should be gradually elevated as suppuration takes place. Indeed very cold applications must be limited ordinarily to a brief period of time, or to that period during which the inflammation is actually culminating.

In confirmation of what we have said as to the hazards of cold applications we shall take the liberty of quoting the following passages from Amussat, on the use of water in surgery:—

"Goursaud reports a case of Guyenot's, in which ice having been applied an hour or two upon a strangulated crural hernia, the hernia was not reduced, and the surgeon, obliged to resort to an operation, found the epiploon frozen; the intestinal knuckle was, however, not injured, and the patient recovered.

"I have notes of the case of a patient affected with a phlegmonous erysipelas of the arm and forearm, with whom the continued application of ice produced a solidification of the pus, so that for its removal it became necessary to resort to shampooing, and very firm graduated compression.

"My father has been often consulted on account of a gangrene which he has thought ought to be attributed to the employment of very cold water; among the cases of gangrene which I have myself seen, there are several which must be ascribed to the same cause.

"I have collected also several cases of patients who having been submitted to irrigations with cold water, have suddenly died with some nervous malady. What part does the cold play in the development of these phenomena? Without being assured that it is the principal cause, I believe I can at least say that it has some agency.

"'Who will affirm,' says M. Richet, 'that the application of a powerful refrigerant upon a large surface will not, by repelling inward upon the viscera the blood which originally abounded in the diseased part, occasion congestions, and give birth to those complications to which I have alluded! The facts are everywhere to be seen, and the practitioner ought to profit by them.'

"'It is well known,' says Sanson, 'that cold applications may cease to be useful, and may even become hurtful, by rendering the flesh œdematous and pale, and causing it to become irritable when suppuration is established in the wounds. Sometimes also they entirely prevent the development of inflammation to such a degree as that at the end of twelve or fifteen days the wound is still in nearly the same condition as at the moment of the accident.'

"M. Apvrille reports a fact upon this point, which occurred in the service of M. Jobert. A woman had received a blow from the horn of a cow, which had torn extensively the skin and superficial muscles of the abdomen; cold water compresses were applied and renewed every ten minutes; when this mode of treatment had been pursued for some time, the wound was found to have made no progress toward a cure, and the cold was suspended. The next day a violent inflammation ensued; again the cold water compresses were applied, and the wound returned to its original condition. A renewed suppression of the compresses was followed by a yet more intense inflammation. Gradually a flabbiness supervened, and the patient died.

"M. Cloquet has remarked to me that he has observed the phenomena noticed by Sanson, in debilitated subjects, when cold has been used perseveringly.

"'Cold,' says Tanchou, 'is only suitable for the young

and robust; with feeble persons, the very old, and with infants, it is always injurious.' This proposition is the more true as the time of the application is the more prolonged.

"One will ask, perhaps, why the accidents of which we speak are not observed more frequently? I answer, that in general surgeons have not taken care to note them, and farther, the temperature and the quantity of water employed in a given time being seldom indicated in the report, it is difficult to understand exactly the degree of refrigeration produced, and whether, therefore, the accident ought or ought not to be ascribed to the cold.

"We see from what precedes, that if cold water possesses some great advantages, it has also many inconveniences, and under certain circumstances it becomes even dangerous. We ought then to prefer tepid water, which calms the pain, and produces the desired effect of subtracting the caloric without exceeding the proper limits, and without exposure to any of the inconveniences of cold water, such as chills, too sudden suppression of the inflammation, and especially gangrene.

Secondary Period.—From the 5th to the 20th or 30th day, usually about the 14th day, secondary hæmorrhages are liable to occur. Indeed during the whole progress of the action of suppuration such accidents may happen, but the limits which we have assigned are those within which they happen most often.

It may be due to the separation of a slough, or to the ulcerative action sometimes attending unhealthy suppuration; in which cases vessels of considerable magnitude, and which have been well secured by the ligatures, are suddenly opened; the vessels giving way generally at the point where the ligatures were applied. Strictly

speaking we think the ulcerative action which separates the slough, rather than the slough itself, is the cause of the bleeding in pretty much all cases, since the bleeding seldom occurs while the dead tissues remain firmly attached to the living, unless the ligature is torn away by violence. In addition to these vessels which have been tied, others which were not tied open also from the same cause. The hæmorrhage may be sudden and profuse, resulting in almost immediate death, or, as more frequently happens, it may be at first very slight and easily controlled, but recurring at longer or shorter intervals, it at length becomes profuse and alarming. The fact is, that at the period at which these hæmorrhages occur the channels of the vessels are generally very nearly closed, and we have seen even the femoral artery lying exposed in a suppurating stump and bleeding at first only a few drops at a time; but the ulcerative action continuing to destroy more and more of the end of the vessel it at length has bled very freely.

The treatment of this accident consists in the prompt application of a ligature in the wound itself in all cases in which it is convenient to do so; and for greater security where it can be done without embracing a nerve, the ligature should be applied with the aid of a curved needle, the needle being thrust well into the adjacent tissues so as to include more than the artery itself. No doubt a ligature thus applied upon the surface of a suppurating wound is not a very reliable mode of arresting the hæmorrhage, but it is a mode commending itself by its simplicity and by its occasional complete success, while it in no way interferes with the employment of other more reliable measures.

Middleton Goldsmith, U. S. V., says he has constantly succeeded with the ligature applied in this way, when he

has previously made bare the nerve by repeated applications of his solution of bromine, and by picking away the dead tissues with the forceps and scissors.

If the ligature cannot be applied within the wound, the next best method is to apply the tincture of the perchloride of iron directly to the bleeding orifices. As we have before remarked, injections of this solution into the track of wounds is attended with considerable hazard, since it is apt to cause excessive irritation and even sloughing of the tissues, nor is it likely to arrest the hæmorrhage: it is seldom also, unless the vessels which bleed are very small, that a direct application with a camel's hair pencil will succeed. The only reliable method is to saturate a pledget of lint in the solution and lay it upon the orifice of the vessel, and placing over this a larger and dry compress of lint, to direct that it shall be held in position by steady pressure made with the fingers or a roller, during a period of one or more hours, or until a firm, hard coagulum is formed which will effectually, for a time at least, seal up the vessel. It is observed that this agent does not usually, when thus applied, coagulate the blood in the vessels themselves, but only outside of their open extremities, and the moment the coagulum is removed from the surface the bleeding is renewed.

The dry powder may be substituted for the solution, but the latter is to be preferred.

We have been informed that Dr. Pancoast, of Philadelphia, recommended as a hæmostatic the following: ℞ Potassæ carb. ʒ i.; saponis (Castile soap, cut fine) ʒ ij.; alcohol f. ℥ iv. It is said not to be escharotic, while it constitutes one of the most active and valuable styptics in use.

The actual cautery, or metals heated to a red or white

heat—less reliable than persulphate of iron with pressure—may be substituted in an emergency. Nitrate of silver, nitric acid, and the other caustics of this class, cannot be depended upon.

Finally, if the bleeding cannot be controlled by any of these measures promptly and completely, then no time should be lost in applying a ligature to the main artery above the wound.

There is another form of hæmorrhage which occasionally takes place at this period, and which, when it is excessive, augurs much more unfavorably than that which has just been described, namely a "parenchymatous" hæmorrhage, characterized by a general oozing from the entire open or granulating surface.

Stromeyer thinks this condition due to the "entrance of air into the veins and a stoppage of the larger veins by coagulation. The stagnation of blood thereby ensuing gives rise to hæmorrhage from the capillary vessels lying free in the wound, and on this account the blood so lost has neither a decidedly venous nor arterial character. Nevertheless I will not assert," he adds, "that parenchymatous hæmorrhages—independent of stagnation in the veins, and similar to scorbutic bleedings—are not met with from the surface of wounds." Whether this theory of Stromeyer be correct or not, we have observed constantly that this phenomenon is coincident with a depraved condition of the vital forces, and that death is likely to ensue speedily even when but little blood has been lost. The indications are to stimulate and sustain the system by tonics, stimulants, and a nutritious diet. As a local application stimulating and astringent collyria, such as sulphate of zinc and superacetate of lead, are serviceable: or we may employ sometimes advantageously the balsams of co-

paiba, of Tolu, or any other of the balsamic or terebinthinate oils, laid on carefully with a camel's hair pencil. The perchloride or persulphate of iron, if employed, ought to be considerably diluted, since upon weak granulations its action is sometimes too destructive.

We must notice also those hæmorrhages supervening upon the occurrence of suppuration which are due to the penetration of spiculæ of bone into large blood-vessels. Such accidents are always to be apprehended in badly comminuted fractures of the femur and of the tibia, and especially when the fragments have been sent in the direction of the large vessels. We have seen examples of hæmorrhage from this cause after the lapse of several months.

Against these accidents we can only provide by carefully removing loose spiculæ, or by enjoining upon the patient as little use of the limb as possible until the danger is past.

Water dressings, which, at a suitable temperature, assuage and control inflammation, are capable of performing, now that the inflammation has ceased, another but equally important rôle, namely the removal of decomposing tissues and of acrid pus; but it is only by adopting the method by irrigation that this is possible.

The advantages of irrigation during the period of suppuration may be briefly stated:

They remove in the most gentle and speedy manner possible all foul and acrid deposits from the surface of the granulations; at the same moment also they protect the granulations from the dry air, impart to them a healthy temperature, increase their tone, and as a consequence render the suppuration more healthy and less abundant. Irrigations diminish greatly the dangers of poisoning by

absorption of pus and ichor. The atmosphere of the wards is kept more pure, and a reciprocal advantage results to all occupying the same wards; there will be less propagation of disease from one to another by either infection or contagion.

Unfortunately there are many parts of the body upon which irrigations cannot be employed, and there are many circumstances under which the confinement which irrigation requires is neither practicable nor judicious, so that we can only employ them in a limited number of cases, and for a limited period.

Water when applied a length of time to the skin occasionally develops a fine, papular eruption. When this occurs it may be regarded as an indication for its suspension; and for the substitution of mild stimulating or astringent ointments such as the resin or the zinc ointments; or we may perhaps disperse these eruptions by medicating the water with the superacetate of lead in the proportions of one drachm to the quart of water. The sulphate of zinc will answer the same purpose.

Water containing a small quantity of lime or of the chloride of soda is also sometimes useful in correcting the fetor. Precisely what virtue these, with many similar articles, possess as disinfectants is not yet determined. If, however, in this respect any of them are entitled to confidence it ought to be the chlorides.

Suppuration.—Open wounds not recent, present a great variety of conditions—that is to say—the tissues may be disappearing by ulceration or molecular disintegration, or they may be gangrenous and sloughing in mass.

These are destructive processes, arranging themselves under the various titles, phagedenic ulceration, traumatic gangrene, hospital gangrene, &c. They will be considered more appropriately hereafter.

On the other hand open wounds, not recent, are in most cases seen to be undergoing the process of repair; granulations are being formed, which indicate the commencement of cicatrization. This process may be feeble, faulty, excessive, or normal, and according as one or the other condition predominates the granulations will be indolent, irritable, fungoid, or healthy, &c.

It is not pretended that all these conditions can be treated successfully by water alone. The most common defect in granulation is feebleness, and with rare exceptions this is due to exhaustion of the general system. Water, rendered more tonic by medication, and mild stimulating unguents, may be serviceable; but without a nutritious diet aided by stimulants and tonics which have the power of giving tone and vigor to the whole body, very little permanent effect can be produced upon the character of the granulations.

Long continued and profuse discharges of pus exhaust the vital forces greatly, and are apt to end at last in obstinate diarrhœa, pneumonia, pyæmia, hectic, and death; which results can only be avoided by careful attention to the condition of the digestive organs, and by supplying to the system nourishment sufficient to compensate for the extraordinary waste. Alcoholic stimulants and wines are capable of improving digestion and of promoting assimilation. When given in quantities sufficient to produce active stimulation they enfeeble the stomach and impair digestion. Confinement in over-heated and ill-ventilated apartments increases this exhaustion, and prevents the cicatrization of suppurating wounds. Multitudes of our soldiers, whose wounds refused to heal while remaining in the hospitals, have speedily recovered their strength and their wounds have become closed, when discharged or sent to their

homes upon a furlough, or when permitted only for a few days to take the fresh air. The case of the gallant Brig.-General Hatch, who was wounded in the leg at the battle of South Mountain, Va., affords an excellent illustration of the value and importance of fresh air. For several months after the receipt of his injury he was confined to his bed in consequence of a profuse and exhausting suppuration, and the opinion prevailed among his medical advisers that some foreign substance had been retained. Under our advice more air was admitted into his apartment, and he was taken out of doors. The suppuration began to diminish immediately, and in the short period of two weeks the wounds were nearly healed and he reported for duty.

Eventually, in cases of protracted suppuration, long and tortuous sinuses are apt to be formed; which, becoming obstructed, do not permit the free egress of matter. These should be opened by broad incisions at an early period; the points selected for the openings being those which are most depending, and if the course of the sinus is superficial, it may be proper sometimes to lay open the track of the sinus through its whole extent. The practice of injecting these canals with stimulating washes is much less often successful; indeed, as a general rule, such injections do more harm than good.

The support afforded by a well applied roller cannot be over-estimated; but, if applied too tightly or irregularly, if in the application the limb is roughly handled, or if its application causes great pain to the patient, it would be better that the roller should be omitted altogether. Suppurating wounds complicated with fractures of the large bones, and in which the bones have not yet united, cannot be handled much without creating mischievous

irritation, and this is especially true in the case of the thigh.

Some surgeons are very fond of pressing out all the mat ter with their hands, and they seem annoyed if the patients do not submit to these well-meant manipulations without complaint. Upon this practice Stromeyer has made a very timely comment. "It is heartily to be wished that the German surgeon would at last free himself from such quack proceedings, for which the patient thanks him but little, since the daily repeated expression of the matter is far more painful and offensive than a suitable incision. I have often heard the patients say, 'The cutting is nothing, but the squeezing is unendurable.'"

It ought to be well understood that granulations, whether forming in the track of a sinus or at the surface, must be treated with great tenderness; any lesion of their delicate structure, whether occasioned by a probe, by the dressings, or by pressure with the hands, and which is sufficient to cause them to bleed, is hurtful; the lesion thus produced must be again repaired, additional inflammation and suppuration result, as a direct consequence of the injury, and in a greater degree the suppuration is increased and rendered more acrid, indirectly, by the decomposition of the blood which remains. The simple act of introducing a probe into an irritable sinus very often develops an irritative fever which continues several days, and not unfrequently determines an erysipelatous inflammation which results in death. Surgeons ought always to have good reasons for probing a suppurating wound; and no rules of mere courtesy will warrant them in permitting others to continue the probing when the exploration has been satisfactory to themselves. We insist upon this, and sincerely desire that it may become a maxim in both civil and military practice.

Violent pressure with the hands up and down a limb, in order that the last drop of pus may be forced out, is more hurtful to the patient than probing, just in proportion as it is more painful. We cannot forget the tremors and the other expressions of alarm with which some of these wretched, attenuated, helpless soldiers see their surgeons approach in their morning rounds. To our mind such expressions are significant testimony as to the competency of the surgical attendants. It is pitiful, when the pressing of the limb commences, to hear the groans and cries of these men, and which no habits of subordination enable them to suppress.

Caution must be exercised even in the removal of detached fragments of bone, when patients are exhausted by long suppuration. In civil practice this injunction is scarcely necessary. Military surgeons understand and appreciate the difference. Wounded soldiers are not generally in the same condition of health as citizens when their wounds are received; the diet and attendance are not always as good; the moral influences are not the same; military hospitals are filled with suppurating and sloughing wounds; erysipelas and fevers contribute to render the atmosphere impure. When, under these circumstances, the life of a patient is trembling in the scale, the weight of a feather may decide the issue, and the most trivial operations cannot always be made with safety. While in the performance of our duties as Medical Inspector in the United States army, we visited the hospital for Confederate prisoners at Nashville, Tenn., and among the wounded we found one man with a necrosis of the tibia, the result of a gunshot injury; he was gradually improving; the fragment of necrosed bone was very small, and lay near the surface; by request of the surgeon in attendance,

and believing ourselves that the operation would be unattended with hazard, we enlarged the opening and extracted the bone easily. Two weeks from this date, when we visited the hospital again, we learned with sorrow that erysipelas attacked the limb on the following day, and that the patient was dead. Similar results, under like circumstances, have attended the practice of other surgeons in several instances which have come under our notice; but this single example will suffice to remind surgeons of a danger which all who have had charge of large military hospitals fully understand.

CHAPTER X.

GUNSHOT INJURIES OF THE HEAD.

SECTION I.—SUPERFICIAL INJURIES. Before entering upon the consideration of gunshot injuries of the head, we desire to call attention to certain anatomical peculiarities in those parts whose lesions we are about to study.

The integuments of the scalp are dense, firm, comparatively inelastic, and composed in a great measure of cellulo-fibrous tissue, which tissue binds the skin very firmly to the occipito-frontalis tendon over the top and sides of the head; they are highly vascular, and lie expanded upon a broad, smooth, and convex surface of bone. The scalp is covered with hair, whose bulbs project far into the subjacent areolar tissue.

The occipito-frontalis tendon, broad, firm, and fibrous—spread out between a large portion of the integument and the skull—is united, as we have seen, to the skin very closely, but to the pericranium very loosely.

The cranium, invested immediately by the pericranium upon its outer side, and by the dura mater upon its inner side, is composed in the adult of two plates, an external and an internal, with an intermediate diplöic structure. The external plate is thin and tough; the internal thicker but more brittle. The diplöe is vascular, and abounds especially in venous sinuses. Between the two periosteal membranes, the pericranium and dura mater, there is an intimate vascular communication. The dura mater is firmly adherent to the inner plate in early life, but

much more loosely in middle life. The inner surface of the skull is grooved at various points by arteries and venous sinuses; and sometimes the arteries, as for example the arteria media meningea, course in a complete canal formed in the walls of the inner table.

The brain is invested by three separate membranes, each possessing a distinct anatomical character—namely, the dura mater, a fibrous membrane, and which has been already mentioned as the internal periosteum; the tunica arachnoides, a serous membrane; and the pia mater, a vascular membrane.

The brain itself, possessed of a most delicate and fragile structure, supported by various duplicatures of its membranous envelopes, occupies all the remaining space within the skull, except that which is necessarily taken up by its numerous afferent and efferent nerves and vessels.

The brain is the organ of the mind, and one of the great fountains of life.

Many of the peculiar results consequent upon injuries of the head will find an explanation in the anatomical and physiological conditions which we have now briefly declared. Some of these peculiar results we will attempt to indicate.

When the integuments of the scalp have been severed, and have once been withdrawn from each other at the point of separation, they are not easily replaced; and if an attempt is made to replace them and maintain them in position by sutures, the tension will often cause the sutures to cut out, and will greatly increase the tendency to inflammation in the adjacent tissues.

When vessels which have been divided have been allowed to retract within this dense structure, it will be difficult to seize and secure them; but compression can be

applied much more effectually here than elsewhere, on account of the breadth and smoothness of the bony structure underneath.

The fact that the scalp is peculiarly prone to erysipelatous inflammation is probably due, in some measure at least, to the dense fibro-cellular character of its structure.

Slight wounds bleed freely, for the reason that its vessels, although not large, are very numerous.

The compactness of the skin, together with the firmness with which it is bound down to the occipito-frontalis tendon, explains the peculiar form of the swellings caused by slight blows upon the head, and in which the skin is not broken. The bloodvessels lying exposed upon this flat or convex surface, and being very superficial, are easily ruptured; and when blood has escaped from the vessels it cannot pass readily from one point to another in the compact areolar tissue, but the extravasation is limited, and the tumor which results is round, abruptly defined, and elastic; indeed, it resembles very much a common encysted tumor. These swellings are very unlike those produced by bloody effusions in most other portions of the body. For example, if a blow is received upon the arm, and blood is effused, the swelling is spread over a broader surface, it is irregular and imperfectly defined in its outline.

The facility with which these bloodvessels are ruptured, will enable us to understand that we cannot always judge of the amount of injury, or of the force of the blow, by the degree of swelling.

The depth to which the bulbs of the hair are thrust into the skin causes them to project sometimes upon the under surface, when the scalp is torn up; and in a few instances we have seen them drawn fairly through upon the under-surface, in such a way that, if the scalp was laid down

before their removal, they would be found to act as foreign substances and prevent union by first intention. They must therefore be seized by the forceps and drawn out, and this can only be done by taking hold of them from below.

If blood is effused under the occipito-frontalis tendon, between it and the pericranium, where the cellular tissue is very loose, it becomes in most cases very broadly diffused, and by this circumstance may be easily distinguished from effusions of blood between the tendon and the skin. The truth is, however, that few vessels lie in this situation, and bloody effusions under the tendon are comparatively rare. But at a later day it is not very uncommon to find here effusions of pus, which dissect up the aponeurosis extensively, and do great mischief before the pus reaches the surface. Occasionally these abscesses are mistaken for fractures accompanied with depression; pus having been poured out, but being limited by fibrinous effusion around the margins of the purulent deposit. This outer fibrinous wall is usually high and precipitous on its inner circumference, but gradually inclines downwards on its outer circumference to the level of the adjacent sound skin; so that when the finger is slid across the scalp it rises imperceptibly to the summit of this inclined plane, and then falls off abruptly as from the edge of a crater. The fibrinous elevation is mistaken for the sound skull, or for that portion whose position has not been disturbed, and the solid bone at the bottom of the soft purulent deposit is supposed to be a fragment of the skull depressed.

Even a collection of half-fluid blood, after the lapse of two or three days, when the parts adjacent have become inflamed and swollen, will sometimes lead to the same error.

Blood is very rarely found effused between the pericranium and skull. The formation of pus at this point is

indicated by the following circumstances. After the lapse of several days from the receipt of the injury, a small puffy swelling appears, accompanied with considerable tenderness and some pain. The original injury may have been very slight, or more severe, and the pain with tenderness may have persisted from the moment of the receipt of the injury, or it may have been first noticed at the period of the formation of the matter. What especially characterizes the formation of matter under the pericranium is the occurrence of the swelling at a late date, its somewhat circumscribed form, and the puffy or œdematous condition of the scalp just over the seat of injury. If the pus continues to accumulate, or if the disease progresses, that portion of the outer plate of the skull from which the pericranium is separated will die and exfoliate; eventually also the capillaries, which establish a communication between the outer and inner tables, will convey the inflammation inwards, and pus will be deposited between the dura mater and skull, giving rise to signs of compression. In this way sometimes apparently trivial accidents prove ultimately fatal.

In other cases the order of events appears to be reversed, and the inflammation, with the consequent suppuration, beginning within the skull, but outside of the dura mater, is subsequently propagated to the pericranium. The tumor which forms under the scalp has the same form and general characteristics, but it is preceded by signs of irritation or of compression of the brain, such as dilatation of the pupils, strabismus, restlessness, partial paralysis of one or more of the extremities, convulsions, coma, &c.

The following is a brief synopsis or resumé of these epicranial tumefactions, and of the various indications of treatment to which they give rise.

First, effusions between the skin and occipito-frontalis tendon, of which there are three kinds; thus a swelling occurring immediately after the receipt of an injury, distinctly circumscribed in its form, round, abruptly elevated, elastic, sometimes of a bluish color, is known to be an effusion of blood between the skin and the tissues immediately subjacent. This is the form of accident which happens so often with children, and which at this moment is illustrated in a man lying in the wards of Bellevue Hospital, injured by the falling of a pile of wood. He has upon his head two of these swellings, one of which is upon his forehead, and quite large. He received a momentary concussion of the brain, but soon recovered his senses completely; under the application of cool water lotions, continued three or four days, these swellings will have entirely disappeared. This is the only treatment which we recommend in similar cases. The blood is in general speedily absorbed, but not while it lies accumulated in mass. Gradually it becomes diffused into the surrounding tissues, and as the diffusion occurs the absorption slowly takes place. A second form of tumefaction, having the same anatomical relations, occurs a little later, and is the result of inflammation. This is composed of serum and fibrin, and its characteristics are too well known to require a more special description. It is the ordinary inflammatory swelling. Occasionally, also, the primary blood swelling or the later inflammatory swelling may result in the formation of pus. In either case the matter points readily, and its evacuation by the knife is easily accomplished. The surgeon is very likely to be deceived, however, by certain changes which sometimes occur in these primary blood-swellings, by which he is led to suppose that suppuration has taken place, when the fact is otherwise. In consequence of the gra-

dual separation of the serum from the fibrin, which latter is deposited with the clot around the circumference of the cavity, the tumor grows soft and fluctuates in its centre, giving to the touch a sensation very much as if it contained pus; but in general, the diagnosis may be corrected by ascertaining whether the present condition has been preceded by much soreness, pain, and throbbing; and especially by observing that if pus has formed, the tension of the skin has been steadily increasing, while, if it is only blood and serum, the tension has been gradually diminishing.

Second. Effusions between the occipito-frontalis tendon and pericranium.—Primary effusions of blood we have declared to be rare at this point; swellings from inflammation are more common, and their results, namely, suppuration and sometimes gangrene, are very destructive. Both the primary effusions of blood and the effusions of pus at a later period may be mistaken for fracture with depression. All forms of effusion at this point are characterized by diffusion.

The treatment first and imperatively demanded, in either case, is early and free incisions; after which, cool or tepid water fomentations are generally required to control the inflammation. Of course, the surgeon will not neglect such constitutional measures as bleeding, cathartics, low diet, and absolute rest, according as one or the other may seem to be indicated.

Third. Effusions between the pericranium and skull.—Here we seldom notice a swelling except as the consequence of the formation of pus, the tumefaction occurring as late as the seventh, eighth, or even fourteenth day; being preceded, accompanied, or followed by pain, tenderness, and signs of cerebral disturbance; the latter always indicating that the brain or its meninges is implicated. The treat-

ment consists in the early evacuation of the pus by opening freely to the bone; and if there is reason to suppose that pus has formed underneath the bone, the trephine must be applied, although it will be admitted that very little encouragement can now be given that this, or any other operation, will save the life of the patient.

Having made these general remarks, we shall now enter upon a more precise consideration of gunshot injuries of the head.

There are many injuries of the scalp which at the first appear very trivial, but which in the end prove fatal. A ball may simply tear the hair from the scalp, and create a very slight abrasion of the skin, yet the bone being so near, and the brain so close to the bone, it is very probable that serious mischief has been done. The cranium under these circumstances may be so injured as to lead to necrosis, or a sufficient shock may be given to the brain and its envelopes to bring on inflammation. The following is a very remarkable illustration of this fact. Colonel Farnham, after the death of Colonel Ellsworth, took command of the 1st Zouave Regiment. At the Battle of Bull Run, July 21, 1861, he received an injury of the character referred to, and which we were permitted to examine. It was a very slight and superficial wound, which seemed to have taken off very little more than the hair. He was transferred from the field to the Washington Infirmary, where he was reported as doing very well, the wound being considered as a very slight and insignificant one, but, notwithstanding all this, he kept his bed, and was observed to be restless and easily disturbed. Yet he did actually seem to be improving until about the ninth day after the reception of the injury, when grave symptoms suddenly supervened, and in a day or two after he died. The autopsy disclosed the

fact that an abscess had formed within the skull. It ought to be mentioned, perhaps, that he was ill before he received the wound, and was unfit to perform duty at the time the battle took place, but being a gallant officer he was determined to lead his regiment to the charge; but his previous condition probably had not much if anything to do with his death, which, in our opinion and in the opinion of other surgeons who saw him, was due directly to the apparently slight injury which he received during the fight.

Pursuing this analysis of the subject, we will next call attention to those examples in which the ball has passed under the scalp. A round ball impinging upon the scalp somewhat obliquely, is very likely to pass under the skin and along for a considerable distance. During the first battle of Bull Run, a man received a ball behind the mastoid process, and it was found above and in front of his ear. When we first saw the case, our suspicion was that the ball had actually entered the head, but on examining carefully, we detected a swelling in front of the ear, and discovered that the ball was lodged there. It was easily removed by a counter-opening. In another case the ball had entered above the ear and passed backwards, and was found lying under the skin at the back of the neck, from which point we removed it by a counter-opening. Both of these balls were very much flattened. We never saw either of the men afterwards, and cannot state the result, but it is probable that some exfoliation of bone took place.

If there is only a wound of entrance in the scalp, and the man is alive and not insensible, it is pretty safe to assume that the ball is somewhere underneath the skin. When found, all that is required for its removal is a counter-opening; this method of procedure, the cut being necessarily a superficial one, is much to be preferred to the extraction of

the missile through the original wound. But it will be observed that necrosis of the bone, at least of the outer plate, is quite likely to result. We have seen frequent examples of necrosis from such a cause. The patient will say that the surgeon cut the ball out, and that, after a few weeks, suppuration took place, and sequestra were in due time exfoliated. The cure may be very tedious, but if the patient be treated properly, if he is guarded from all excitement, and his bowels kept soluble, he will generally get well.

The ball may have fractured the skull and have caused some slight depression; in which cases it generally rebounds and falls out.

If the depression is slight, and there are no signs of irritation or of compression of the brain, if we have reasons to believe there are no spiculæ of bone projecting into the brain, then we do not trephine; the patient's chances of recovery are better if let alone than if we proceed to operate.

The difference between this accident and similar injuries occurring in civil practice, where in most cases the fracture has been caused by other substances than bullets, is very great.

The poor man lying in the hospital, to whom reference has already been made, was injured by the fall of a load of wood upon him. Now, imagine the difference of effect which such an injury would produce upon the brain compared with that which a bullet would inflict. The ball, even when its velocity is nearly expended, impinges upon the skull with a dead and solid weight. Hence it can be easily understood how, when the external evidences of injury are comparatively slight, the brain may be seriously compromised. When a piece of wood has fallen upon the head, although the aggregate weight of the mass may be

very disproportionately great, the momentum is comparatively inconsiderable.

The danger in the case of gunshot injury which we have supposed, is not that the patient will die of compression, but that the concussion will result in inflammation of the brain or its meninges; and it is observed that in trephining, sufficient additional injury is often caused to turn the balance in the scale against recovery. The proper local treatment, then, consists in applying cloths wet in cold water to the head; while the constitutional treatment consists in a rigid diet, perfect quietude, cathartics, with perhaps antimonials and bleeding. It is our opinion that venesection is of late too much undervalued, and that in these inflammations of the brain, especially, we do not sufficiently understand its value, more especially in patients of full habit. It is true that the brain is peculiarly situated, being shut up in a firm, bony, and unyielding casement, and by the laws of hydrostatics we cannot expect much blood to be drawn from it; but then we can at least greatly diminish the action of the heart, and perhaps render the blood itself less stimulating.

Section II.—Perforating Gunshot Injuries of the Head. It is an observation of Mr. Guthrie, we think, that while injuries of the base of the brain are of all most fatal, the fatality of injuries in the upper portions diminishes as you proceed from before backwards; that is to say, injuries of the anterior portions are the most fatal, injuries of the middle portions less so, and injuries of the posterior portions least of all.

What is the exact amount of injury which the brain may sustain without producing death we are unable to say; but it is surprising to note how much cerebral structure

may be destroyed or removed in one instance without causing death, and on the other hand how slight a lesion of the same organ in another case may result fatally.

One of the most extraordinary cases of recovery upon record, probably, is that of the man Gage, who was shot through the head with a tamping-iron three feet seven inches in length, one inch and a quarter in diameter at its largest end, and weighing thirteen pounds and a quarter.

The accident occurred in 1848; and Dr. Harlow, of Cavendish, Vt., in whose practice it took place, described the wound as commencing just anterior to the ramus of the inferior maxilla, on the left side, taking a direction upwards and backwards towards the median line, and terminating at the junction of the coronal and sagittal sutures. In its course this huge mass of iron had traversed the left anterior lobe of the cerebrum, extensively fracturing the frontal and parietal bones, protruding the globe of the left eye from its socket by nearly one-half of its diameter, and lacerating the superior longitudinal sinus. In 1860 this man was still living and in the enjoyment of good health.

This single example will suffice to illustrate what terrible injury the brain may sometimes suffer without causing death, or indeed entailing any serious consequences; and may properly encourage a hope for a successful issue in many of the most unpromising cases.

If the ball has perforated the skull, and life is not extinguished completely, the surgeon ought at once to examine the wound at the point of entrance in order that he may remove such small spiculæ of bone as may lie near the orifice; and if larger fragments are driven in they should be elevated, and, when they cannot be extricated otherwise, the trephine or Hey's saw should be applied.

If any of the large sinuses have been opened the bleed-

ing will generally be very profuse, but in most cases, when there is a free external opening, it can be arrested, at least temporarily, by moderate pressure.

A few days ago a lad, about ten years of age, was brought into the wards of Bellevue Hospital, whose skull had been fractured by the wheels of one of the street cars. We found him soon after the accident insensible and greatly exhausted by the loss of blood, which had been flowing freely from the lateral sinus. A large portion of the occipital bone had been broken up and torn away, but a loose fragment was resting over the wound in the sinus. Dr. Lauderdale, the intelligent House Surgeon, had noticed that the weight of this fragment was sufficient to stop the bleeding, and that when it was lifted by the forceps the blood flowed freely. We removed the fragment and exposed a laceration of the sinus more than half an inch in length; but the bleeding was at once arrested completely by a pledget of lint secured in place by a light turn of a roller. The hæmorrhage did not recur, but the patient died during the night.

If the bleeding is from an artery within the skull it will be found much more difficult to control, but it may sometimes be arrested by pressure made with the finger, the pressure being made from the inner surface of the dura mater towards the skull; sometimes even a pledget of lint will control it, and in a few examples the great meningeal artery has been found so completely buried in the inner plate of the skull that a small wooden plug has served to arrest the hæmorrhage.

We ought not to omit to mention that in case the wound is made by a round ball, and especially if it has been discharged at short range, the opening in the skull is frequently quite round and not larger than the ball itself;

and in a few instances there will be found no line of fracture or of fissure extending from the circumference of the opening in any direction. We may see the same phenomenon exemplified in the circular hole made through a pane of glass when a pistol ball is sent through with considerable force. If, however, the ball is moving slowly, or if it is a conical ball, the skull is likely to be more or less extensively broken, and especially at the point of exit.

The following example will illustrate how much nature can accomplish, under the most unfavorable circumstances, without aid from the surgeon. Corporal George W. Monk, 78th N.Y.V., 12th Corps, at the battle of Chancellorsville, May 4, 1863, nine months ago, received a ball, which penetrated the right parietal bone near its posterior-superior angle; he fell to the ground in a state of insensibility, but does not think he remained long in this condition; when consciousness returned, he put his right hand to his head, and passed his finger into the wound one or two inches. His left arm and both of his legs were at this moment paralysed. He remained upon the field three days, and on the third day, after having been exposed without shelter to a cold and drenching rain, he was seized with convulsions. The convulsions have occurred at intervals from that day until the present time, but the paralysis has disappeared entirely except from his left arm, and in this limb it remains in only a slight degree. Several fragments of bone, including both plates, have escaped from time to time, but no surgical operation was ever made. The wound continues to discharge pus in a moderate quantity. The ball has never been found, and although we can scarcely doubt that it was withdrawn with his cap, which he says was perforated, yet it is possible that it remains within the skull.

It is a point worthy of remark in this case, that at the

end of three weeks a secondary hæmorrhage took place, probably from the median meningeal artery, and which came near proving fatal. It was finally arrested by plugging the wound with lint. About four weeks later a second hæmorrhage occurred, but at this time it was more promptly arrested.

At Sharpsburg, Va., we saw on the 11th of October, 1862, private D. A. Kemper, of the 15th South Carolina Regiment (Confederate), who had been wounded at the battle of Antietam. A rifle ball had struck the back part of the occipital bone, a little to the left side, tearing up the flesh, breaking and depressing slightly both tables of the skull. The ball lodged under the scalp, and was not found until the fourth day. No symptoms of injury to the brain ensued, and we found him on the twenty-fourth day walking about, the wound nearly closed and feeling perfectly well. The only surgical interference which had been practised was the removal of the ball from under the skin on the fourth day. The treatment had consisted in rest, low diet, and cool water dressings.

In the same hospital was Lieut. M. A. Grant, of the 12th N. Y. Cavalry, who had been wounded four weeks previously at South Mountain by the fragment of a shell. The skull was fractured and slightly depressed. No attempt was made to lift the bones. He was delirious several days, and had convulsions on the sixth and seventh days; but the delirium and convulsions ceased after a free bleeding from the temporal artery. When we visited the hospital he was improving rapidly, all signs of meningitis having long since disappeared. There was no paralysis, and the convulsions had not returned.

SECTION III.—PENETRATING GUNSHOT WOUNDS OF THE HEAD. When a ball has fairly entered the cavity of

the cranium, and no counter-opening can be found, it is fair to assume, as a general rule, that the missile remains within the skull; although it is certain that in a few instances it has been accidentally drawn out by some portion of the cap or other portions of the clothing which covered the head.

Surgeons have collected, after many years, a considerable number of examples in which balls have remained thus buried within the skull without causing death during many weeks or even months; these balls being inclosed, as the autopsy has finally shown, in perfectly formed membranous cysts.

When the Army of the Potomac advanced towards Fairfax Court-House, on the 29th of September, 1861, we found living near Munson's Hill a man named Mortimer, who, being suspected of being friendly to the Union, and of conveying information to our pickets, had been shot at his own door by the Confederates. This happened the next week after the Zouaves took possession of Alexandria, some time in June of the year 1861, and he had never been able, until our lines were advanced, to obtain any surgical advice. He stated that he received at the same moment three buckshot, one of which entered the right shoulder, one the left shoulder, and one penetrated the skull near the middle of the forehead. None of these shot had ever been removed, but those in his shoulders gave him no inconvenience. The first effect of the injury to his head was to render him unconscious, but from this condition he soon recovered, and has been able ever since to walk about a little; walking fast, however, or stooping down occasioned severe vertigo. The same effect was produced by any mental excitement. His limbs were weak, but not paralysed. He informed us that he felt a weight or sensation in the back of his head, as if the shot was there. The wound was still discharging,

and whenever it closed, as it did occasionally for a short time, his symptoms were greatly aggravated. We saw this man again on the 26th of January, 1862, about eight months after the receipt of the injury, and found that no material change had taken place in his condition.

Acting-Surgeon Dase, U.S.A., has reported the case of Corporal Shone, of the 12th Mass. Vols., who was wounded at the battle of Fredericksburg, Dec. 13, 1862, by a conical ball, which, entering the orbit, became lodged underneath the dura mater, but fairly within the skull, near the sella turcica. In this case no cerebral symptoms manifested themselves until about seven weeks after the receipt of the injury. His death occurred from the formation of an abscess in the anterior lobes of the brain, at the end of eight weeks.*

Dr. Botter, of Seneca Co., New York, reports also an example of a conical pistol ball lodged at a depth of three inches in the right anterior lobe of the brain, and from which the patient died at the expiration of ten weeks. During the first eight weeks no marked cerebral symptoms were present.†

In a Philadelphia journal for 1858 we read as follows:— "A man named Courshan was yesterday convicted in the Court of Quarter-Sessions of an assault and battery with intent to kill. A number of colored men got into a street brawl about a woman, and one of them fired a pistol at another of the party, a sailor. The slug from the pistol pierced the skull of the sailor, and buried itself deep in the brain. The wounded man was taken to the hospital, where his wound was dressed without the ball being extracted, and the sufferer was left to die. But he did not die. In

* Am. Med. Times, April 25, 1863.

† Ibid. June 13, 1863.

the course of time he got well, and he has actually gone to sea with a slug in his brain."

Hennen mentions that he has seen "no less than five cases where a ball has lodged in the substance of the cerebrum without immediately producing a fatal event." Lawrence found a pistol bullet in the brain of a young man which had entered the roof of the orbit, and, having traversed the anterior part of the cerebrum, was arrested by the skull near the coronal suture. He had survived the injury two weeks without presenting one single symptom to indicate that the brain was injured.

Guthrie relates that, "during the war with the United States, in 1814, a soldier in Canada was struck by a ball which lodged in the posterior part of the side of the head; the wound healed, and the man returned to duty. Twelve months afterwards, having got drunk, he fell in the streets of Montreal and died. The ball was found lying on the corpus callosum, where it had made a hole or sac for itself." The same writer mentions a similar case in which, the ball having been received at the battle of Waterloo, the man got well and went home, but in a fit of intoxication he suddenly fell dead. The ball was found lodged in a cyst in the posterior lobe of the brain.

We have taken the pains to call attention to a few of these remarkable examples in order that the surgeon may understand the possibility of the patient's surviving a certain length of time, even though the ball should not be removed, and to impress the necessity of enjoining upon such persons strict habits of temperance, and the avoidance of all sources of mental or physical excitement. It is easily seen, however, that the results do not warrant us in permitting a ball to remain, whenever it is possible to accomplish its removal.

Those who are curious in these matters may find addi-

tional cases collected by Mr. South in his notes to Chelius's Surgery; the longest period during which the patient survived being eighteen months. This was in the instance mentioned by Langlet. The ball weighed seven drachms.

Other foreign substances, when not projected by powder, have remained for much longer periods. Trumbull speaks of a child in whose brain a piece of an iron spindle, three inches long, was lodged for a period of eight years, but who finally died from the effects of the removal. Larrey states that a portion of the blade of a javelin was successfully extracted from the brain after fourteen years.

What, then, shall we do if a ball has entered the skull and has lodged? Shall we introduce a probe and explore freely until it is found? Shall we trephine the skull, so as to enlarge the external opening, and then proceed to search for the ball more thoroughly? Certainly not. In the first place, the ball has not always passed through the brain in the same direction in which it entered. We have in our possession a portion of a skull, taken from a soldier who was killed at the battle of Fair Oaks, on the 1st of June, 1862, which will illustrate this statement. The specimen was presented to us by Dr. Swinburne of Albany. This ball, a conical ball, entered the skull somewhat obliquely, and its side coming in contact with the opposite margin of the broken bone, it was immediately deflected from its original course, and its track through the brain was found to be at a considerable angle with the line of its entrance. When the ball struck upon the opposite margin of the broken skull, it was nearly cut in two, but it still retained sufficient momentum to traverse the brain to its base.

Moreover, the natural structure of the brain is so soft and fragile that when we introduce a probe it is almost impossible to determine whether we are following the track

of the ball or not. If the probe falls in by its own weight it is probably following the ball, but if it requires some force to move it forward, one cannot be certain where it is going. The finger is a safer instrument, but even this may be plunged into the structure of the brain without our being conscious of the error.

It is pretty certain, also, that a ball which has been projected with sufficient force to enter the cranium, will have enough force remaining to penetrate very deeply, if not entirely through the brain.

Larrey once traced out and removed, by a counter-opening made with the trephine, a ball which had passed several inches along the course of the superior longitudinal sinus; and some other cases are mentioned in which a ball has been found and successfully extracted which lay quite deep within the structure of the brain. It is much more common, however, to find examples of successful removal recorded in which the missile has merely entered the skull and has been found upon the dura mater. In such cases, if the opening is not sufficiently large to enable the operator to extract the ball, the trephine may be required.

Dr. Hann, Surgeon, U.S.A., relates a case in which he found the ball resting upon the dura mater, directly under the skull. He trephined the man, removed the ball, and the recovery was complete.

Section IV.—Convulsions. Among the results of gunshot injuries of the head, we must not omit to mention *convulsions*, and which occur under such a variety of circumstances that it is not very easy to explain their exact pathology. They occur at all periods of time, from the moment of the receipt of injury to the latest day of life; in many instances the first attack is after the lapse of ten

or fifteen years, but when convulsions have once occurred, they are prone to continue during life. Our own observation leads us to think that after gunshot accidents, they are most likely to be announced between the third or fourth and tenth day, or at the time of the accession of inflammation of the meninges, or of the brain. In the great proportion of cases, also, fragments of bone have been found pressing inwards upon the brain. Sometimes the pressure of extravasated blood has seemed to be the only provocation, and, at a later day, effusions of serum or of pus. It may be proper to infer, perhaps, that in all these cases irritation, established either directly or indirectly, is the cause of the convulsive muscular contractions.

We will cite a few illustrative examples. Two have already been mentioned, namely, the case of Lieut. Grant, in whom the convulsions commenced on the sixth day, but ceased on the following day after a free bleeding from the temporal artery. The skull was slightly depressed, but no attempt was ever made to change its position. The second case was that of Corporal Monk, in whom the convulsions began on the third day, and still continued after the lapse of nine months; it is possible that in this case the ball remains within the brain.

James McKabe, of the 4th N. Y. V., was wounded on the 17th of September, 1862, at Antietam, by a ball which grazed the right parietal bone, breaking and slightly depressing the fragments. No surgical operation was then made. On the fourth day he had convulsions; his surgeon removed the broken pieces, the convulsions ceased, and when seen at Frederick City, Md., four weeks later, they had not returned, but a paralysis of his left side remained.

Sergeant Monroe Halloway, of the 67th Ohio Vols., was wounded at Fort Wagner, August 18, 1863, by the frag-

ment of a shell, which fractured the right parietal bone at its superior and posterior angle, producing a slight depression. He was for a time unconscious, but soon recovered. After the lapse of about forty-eight hours he began to have convulsions, and they continued a week or more. The fragments were then removed, and the convulsions ceased. Four months afterwards we found the wound still open, but the convulsions had never returned; he had no paralysis, and was walking about; indeed, he declared that he felt well.

In the following example partial convulsions were produced by an attempt to remove the broken pieces.

Private Edmund Gordon was shot while on picket duty near Yorktown, Va., September 18, 1862, the ball breaking in the skull near the anterior inferior angle of the parietal bone of the left side. He remained all night on the ground. When he reached the hospital he was unable to speak, but he seemed conscious and could walk. The loss of the power of speech, together with the depression of the fragments, seemed to authorize the use of the trephine. After having removed a circular piece of bone, and while lifting the depressed fragments, the left side of his face became violently convulsed, but this ceased when the fragment was removed. A pretty free hæmorrhage, which immediately occurred from the middle meningeal artery, ceased spontaneously in a few minutes, apparently from the pressure of the brain from within. Two days after we found him doing well, but we have heard nothing from him since.

In one case it will be noticed that the convulsions ceased upon the occurrence of free hæmorrhage; this circumstance will suggest what the experience of surgeons has occasionally taught, namely, that bleeding will, in some cases, prove a useful remedy.

Section V.—Hernia Cerebri. Hernia of the brain is fortunately a rare sequence of gunshot injuries. We say "fortunately," because it must always be regarded as a grave complication. Very few indeed in whom the hernia is well developed ever recover.

The hernia generally commences a few days after the occurrence of the injury; most often, perhaps, between the fourth or eighth day and the fourteenth, but it may occur earlier or later. It seldom follows very extensive lacerations of cerebral structure, or those injuries in which large portions of the bony parietes have been removed. It is still less frequent where the dura mater has not been torn. In short, we have the most reason to anticipate a hernia when the opening in the skull is of moderate size and the meninges are at the same time ruptured.

Pathologists are divided in their opinion as to the nature and cause of this protrusion. Perhaps its causes are not always the same. It is quite probable that in some cases there is a true fungous growth, the result of the effusion of lymph and of the formation of new vessels; and that in other examples there is only present a bloody tumor, consequent upon an effusion of blood into partially organized lymph. The descriptions occasionally given of these cases seem to warrant such an opinion, but it has never happened to us to meet with such examples.

The opinion which we entertain is, that in a large majority of cases described as hernia cerebri, there is an actual protrusion of the brain; and moreover, that this is caused, like all other hernial protrusions, by a centrifugal pressure. No doubt, whenever some time has elapsed since the occurrence of the hernia, a pathological change will take place in the condition of the structure; it will become congested, swollen and inflamed, and present under the

microscope new tissues in great abundance, and perhaps eventually the original structure may be entirely lost; yet it will be no less a cerebral hernia, than a strangulated, congested, swollen, and enlarged or disorganized omentum escaping through the abdominal walls, is an omental hernia.

The conditions which may give rise to a hernia cerebri are, congestion or inflammation of the entire mass of the brain or of portions, effusions of lymph, serum, or pus into the cavities of the brain, upon its surface or into any part of its structure. Probably in most cases the hernia is due to an effusion of pus in some point of the structure of the brain—that is, to the formation of an abscess, or to the effusion of serum into the ventricles.

We have thought it necessary thus briefly to state our opinions upon this subject because our views of the practice which ought to be adopted differ widely from those entertained by some other surgeons.

The essential, primary cause of hernia cerebri is congestion or inflammation of the brain or of its meninges. It is to be prevented, therefore, by the adoption of such measures as are calculated to obviate inflammation, and especially, in certain cases, by the use of the lancet.

When a hernia cerebri has actually occurred, it demands the continuance of mild antiphlogistic measures, and the employment of such simple local applications as will diminish the tendency to engorgement in the part, among which none will be found more generally useful than *moderate* pressure, conjoined with cool and astringent lotions. Sir Astley Cooper recommended for this purpose lint moistened with a saturated solution of lime-water.

Beyond the employment of these simple means, there is in most cases very little to be done. We have only to

wait patiently in the hope that such effusions as have taken place may be absorbed, or that they may make their way to the surface and escape externally.

If any alternative is presented, it must consist in the use of a knife or the trocar for the purpose of reaching and giving exit to the effusions; an alternative which is not without the authority of precedent, but which, it must be confessed, offers very little hope for a final cure.

Case.—On the 13th of September, 1855, Leo Keogh was struck upon the left parietal bone, causing a fracture of the skull, and on the following day, assisted by Dr. Spearman, who was in charge of the patient, we removed several fragments of bone. During the operation an opening through the dura mater was observed of about one-fourth of an inch in length. No brain had escaped. He remained paralyzed upon the right side and partially comatose. From the condition of coma he gradually recovered, but the paralysis continued. About two weeks from this time a hernia cerebri began to develop itself. On the 5th of November the hernia had attained the size of the half section of a pomegranate, being three inches in diameter at its broadest part. He had had two convulsions, and the paralysis continued. Soon after this date, in attempting to examine beneath the base of the tumor with a probe, pus was observed to escape freely; and from this time the hernial protrusion gradually diminished in size, and finally disappeared entirely. His recovery was complete, except that a partial paralysis of his right arm and leg remained at the expiration of two years. The local treatment throughout consisted in the application of cool water saturated with lime.

Case.—On the 22d of December, 1863, Felix McAllon was admitted into one of the surgical divisions of Bellevue

Hospital under our charge, having a fracture of the right parietal bone. The fragments being depressed, we trephined him on the same day. No wound of the dura mater was discovered. On the twelfth day he had so far recovered as to walk about the ward. On the fourteenth day he walked into the amphitheatre and presented himself before the class of medical gentlemen there attending the lectures at Bellevue College. On the sixteenth day he became comatose and a hernial protrusion appeared. On the same day, believing that an abscess had formed, we introduced a probe underneath the hernia, penetrating the brain about three inches; but no matter escaped. During the night of the seventeenth day a sudden, almost instantaneous increase in the size of the hernia was observed, and a few minutes after he died.

After death, and before the autopsy was made, we expressed to the medical class our conviction that we should find an abscess; and the examination made a few hours later disclosed the fact that an abscess had formed in the structure of the brain, the outer wall of which was about one and a half inches below the external wound. It contained about one ounce of pus. The track of the probe which had been introduced was distinctly traced leading into the abscess; but as no matter had followed the introduction of the probe, it is probable that the opening was not sufficiently free.

CHAPTER XI.

GUNSHOT INJURIES OF THE FACE AND NECK.

THE face is composed of a large number of bones, most of which are light, thin, or shell-like in their construction, and unite with each other by very irregular surfaces. They are therefore peculiarly subject to comminution, and to displacement when broken; and they cannot always be easily restored to their original positions. They are highly vascular; and consequently their lesions expose the patients to both primary and secondary hæmorrhages. It is due, also, to their excessive vascularity that they reunite with great rapidity, and under the most unfavorable circumstances.

This class of injuries possesses additional interest from the fact that they are apt to entail ugly deformities, and to mar seriously the beauty and expression of the face.

These injuries, moreover, frequently maim or destroy completely the organs of sight, hearing, taste, and smell—indeed all of the organs of special sense except touch.

We find it impossible to discuss in detail all the varieties of accidents to which these complicated structures are exposed from balls and other missiles, and we shall content ourselves by making a few general observations; taking it for granted that the previous study of the surgeon has rendered him familiar with the anatomy of the face, and with the various expedients which ophthalmic, aural, dental,

and anaplastic surgery have devised for the treatment of its numerous lesions.

Missiles entering and lodging in the face ought to be extracted as speedily as possible; and whenever it is practicable, they should be removed through the mouth. If permitted to remain, they expose to the danger of secondary hæmorrhage, and increase the chance of subsequent disfigurement.

Loose fragments of bone should be speedily replaced, unless very much detached from the flesh and periosteum, experience having proven that they unite in most cases with great facility.

No piece of skin which is torn up should ever be removed unless it is absolutely dead, but it should be laid back carefully into place and retained by either a few delicate sutures, or by some other gentle means of support. Tight ligatures and firm straps of adhesive plaster are apt to bind the tissues and destroy their little remaining vitality. The best mode of supporting a fragment of skin in place, in many cases, is to lay upon it a thin piece of lint smeared with cerate, and over this a pledget of cotton batting, securing the whole with adhesive plaster or a roller.

As soon as the inflammation and consequent induration have completely disappeared, and not before, it will be proper to make the final anaplastic operations.

Persistent primary or secondary hæmorrhage may be arrested by the direct ligature, by pressure sometimes, by cold applications, by the persulphate of iron, etc.; but in extreme cases it will be necessary to ligate the external carotid; rarely, if ever, the common carotid.

Among the curious accidents to which the face is liable we will mention that of a Confederate soldier who was

wounded at the battle of Stone's river in Tennessee. He was kneeling and bending forwards when he received a rifle ball upon the crowns of his four lower incisor teeth. The ball and teeth disappeared, but were subsequently removed from underneath the skin at the top of the sternum. We saw this man when the wound over his sternum was about to open again, probably for the discharge of some fragments of bone or other foreign substance. He had never experienced any difficulty in breathing or in deglutition.

Balls sometimes traverse the neck without inflicting serious injury upon any of those important structures which are here assembled and crowded together as upon a narrow isthmus; but unfortunately in most cases important nerves are found to have suffered lesion, or large bloodvessels have been torn asunder, and death occurs speedily.

For the lesion of these nerves, surgery furnishes no remedy.

When the arteries are torn asunder, nothing but the prompt application of the ligature is usually of any avail; and it is seldom that the surgeon is sufficiently near to render assistance in the primary hæmorrhages of such arteries as the innominata or carotids.

Wounds of the trachea are not necessarily or generally fatal, at least not immediately. They ought never to be closed until after the lapse of several hours from the time of the receipt of the injury, and not until all hæmorrhage has ceased for some time.

When the œsophagus is wounded, the first duty of the surgeon is to pass a stomach-tube from the mouth into the stomach, which he will permit to remain until the wound is closed. If he omits to do this before inflammation and

swelling have taken place, he may find it impossible to introduce it afterwards. At this moment he may be aided in the operation by introducing one finger into the wound as a guide.

For a further consideration of injuries of the upper and lower jaws, we refer the reader to the chapter on "Gunshot Fractures."

CHAPTER XII.

GUNSHOT WOUNDS OF THE THORAX.

GUNSHOT injuries of the thorax may be divided into, first, superficial or those in which the projectile has not entered the cavity of the thorax; second, perforating, or those in which the projectile has passed entirely through this cavity; third, penetrating, or those in which the projectile has entered the cavity of the thorax and remains.

SECTION I.—SUPERFICIAL INJURIES, OR THOSE IN WHICH THE MISSILE DOES NOT ENTER THE THORACIC CAVITY. A rifle or musket ball, which merely impinges upon the surface of the skin and glances off without producing any lesion of structure, is usually harmless. Unlike similar injuries of the scalp, it in general produces little or no nervous shock, and entails no serious results. If, under such circumstances, the patient looks pale and seems exhausted, these phenomena are generally due to alarm occasioned by the belief that he has received a mortal wound. At Centreville a soldier requested us to examine his back, through which he said a ball had penetrated. He had walked from the field and looked pale and exhausted. Upon examination, we found a discolored spot which he indicated as the seat of the injury, but no wound. He stated that the ball struck him with so much force as to make him stagger, and that he immediately experienced

some difficulty in breathing, which was perhaps in part caused by the alarm, and in part by an injury to some small nerves. Occasionally, however, the shock produced by a musket-ball is sufficient to cause a rupture of some of the more superficial pulmonary vessels; and in other cases it gives rise eventually to pleuritis or even pneumonia.

Guthrie relates that, on the 17th of August, 1808, when the army under Wellington was about to ascend the heights of Rolica, a soldier received a ball upon his buff-leather belt on the right breast. The noise made by the blow was quite audible. Mr. Guthrie saw the man fall, and supposed he was killed; the ball had, however, only gone through his belt, and made a mark on his chest over the cartilage of the fourth rib. He recovered in a short time, spat a little blood in the night, and, after a large bleeding, was enabled to accompany the troops on the 20th, ready for the fight the next morning.

A solid shot, or the convex surface of the fragment of a shell, may impinge upon the thorax, and without causing any rupture of the skin or anything more than a slight abrasion, it may fracture the ribs, rupture the lungs or some of the large bloodvessels, or even tear open the heart itself, and thus cause almost immediate death. In these cases the injury resembles those crushing accidents which often occur in civil life; and the fatal internal lesions are produced rather by the weight than by the momentum of the projectile. The ribs, with their cartilages, are bent inwards violently, and made to encroach very far upon the contained viscera before they break, and serious lesions may be produced before the bony parietes are fractured; but when at last the ribs themselves are broken, their ragged extremities are thrust violently inwards, and the internal lacerations are rendered more extensive.

McLeod mentions the case of a soldier who was hit by a round shot on the edge of the breast-plate, which was so turned in as to fracture the cartilages of the fifth, sixth, and seventh ribs on the left side, close to the sternum. The skin was not wounded. He walked to the rear, and complained but little for two hours, when he was seized with an acute pain in the region of the heart. His pulse became much accelerated, and he grew faint and collapsed. A distinct and sharp bellows-sound accompanied the heart's action. He died in seventy-two hours from the receipt of the injury; the pain and dyspnœa, which had been so urgent at first, having abated for some hours before death. The heart was found to have been ruptured to an extent sufficient to allow of the finger being thrust into the left ventricle. The obliquity of the opening had prevented the blood escaping into the pericardium, which contained about two ounces of dark-colored serum.

The elasticity of the ribs is such, also, that solid shot frequently tear off the flesh extensively, uncovering the ribs over a space of several inches without producing a fracture.

In several instances we have seen the side of the thorax covered with a dark-colored eschar caused by a solid shot, but in which cases the destruction of tissues extended no deeper than the integument. During the shelling of our camp on the night of August 1, 1862, at Harrison's Landing, our attention was called to an accident of this kind. The man who had received the injury was a private, belonging to the Fourth Pa. Cavalry, and the shot had taken effect upon the left side of the thorax, over the fifth, sixth, seventh, and eighth ribs. A surface about the size of the hand was covered with a dark-brown eschar, but none of the ribs were broken. He was knocked down by

the missile, and was for a moment unconscious. Several days later we found him still in bed, feeling very weak, and complaining of a burning pain in the eschar, but no symptoms had supervened indicating the occurrence of any internal injury.

Round balls have been frequently known to penetrate beneath the integuments, and pass around the outer circumference of the chest for a greater or less distance, escaping finally at a point so remote from the point of entrance as to have led to the belief that the ball had passed directly through the cavity of the chest. It is supposed that the force of these balls must have been nearly expended before coming in contact with the body, and that they struck obliquely; which circumstances, together with the remarkable elasticity of the bony parietes of the thorax, will sufficiently explain the eccentricity of their course. In some examples the ball, having entered near the centre of the thorax in front, has escaped directly opposite, near the spinal column; indeed, the projection of the spinous processes of the vertebræ generally determines the extent of the circuit in this direction, the ball being at this point either arrested and remaining lodged beneath the skin, or deflected towards the surface and making its escape.

Conical balls, as we have already stated in our general remarks, are much less liable to be thus deflected, nevertheless we still continue to meet with similar accidents occasionally.

Section II.—Perforating Gunshot Wounds of the Thorax, or those in which the Projectile has passed entirely through the Thoracic Cavity. We include in this division not only those accidents in which the perforation is complete, the ball having escaped through

the opposite integuments by its own momentum, but also those in which the ball, having traversed the thoracic cavity, is found lying more or less superficially outside of the thorax, in a position from which it may be easily removed by the surgeon.

Perforating gunshot wounds of the chest present the widest range of prognosis, according to the direction which they have taken and the particular viscera which have suffered lesion.

Wounds of the heart and of the large bloodvessels are in general immediately fatal. We are seldom in a position to witness the death of a man who has been shot through the heart, but the author has had one unusual opportunity of witnessing the death of a soldier whose heart had been penetrated by bullets.

While the army of the Potomac was encamped in front of Alexandria, Wm. H. Johnson, a private in the 1st N. Y. Vol. Cavalry, was shot for desertion. The execution occurred on the 13th of Dec., 1861, and we were stationed with Gen. Franklin and his staff only a few yards from the culprit. The detachment of soldiers by whom the sentence was carried into execution consisted of twelve men, and was divided into two squads, composed respectively of eight and four men, the latter being held as a reserve. The arms used were Sharp's carbines, loaded with conical balls. The distance was five paces. At the first fire four balls entered his chest, three penetrating the heart. The remaining balls did not take effect. After he was shot, during a period of two or three seconds, he sat motionless, and then fell slowly over to one side and to the ground. At this moment a slight convulsion passed through his frame, and the officer in command, supposing that he was not fatally wounded, ordered the reserve to fire, and their balls were

found subsequently to have penetrated the face and head. We immediately rode to him and ascertained that he had ceased to breathe and was pulseless. He was dead. It is probable that the three balls which penetrated his heart, and which, as the autopsy showed, had lacerated it freely, produced death in less than five seconds.

Dr. Samuel S. Purple of this city, in a most excellent monograph on "Wounds of the Heart,"* has furnished a resumé of twelve cases of gunshot injuries of this organ in which the patients survived the accident a considerable length of time, the periods ranging from forty-four hours to six years.

In one of these examples, reported by Dr. L. Randal, the patient having died on the sixty-seventh day, three shot were found lying loose in the right ventricle, and two in the right auricle. The wounds had cicatrized.† In the case reported by Fuge, the patient died on the fourteenth day, and the ball was found lodged in the pericardium. In the case reported by Dr. R. C. Hopkins, the patient survived also fourteen days, and a pistol-ball was found in the wall of the left ventricle.‡ One survived thirteen days with the ball in the left ventricle. Carnochan's patient survived eleven days. After recovering from the first shock, he remained well until the ninth day. The ball was found encysted in the walls of the heart.§ The patient reported by Malle lived forty-seven days with a piece of wood transfixing the left ventricle and projecting fairly into the right; and Davis has recorded a similar case, the result of a gunshot accident also, in which a stick, three inches long,

* New York Jour. of Med., May, 1855.

† Western Jour. Med. and Phys. Sci., vol. 2, p. 329.

‡ Ohio Med. and Surg. Jour., vol. 5, p. 210, 1853.

§ Amer. Med. Monthly, vol. 3, p. 272.

remained thirty-seven days in the right ventricle before it caused death. In the Indian Annals of Medical Science a man is declared to have survived ten weeks with a musket ball in the cavity of the left ventricle. Finally M. Fournier, in the *Dictionnaire des Sciences Medicales*, under *Cas Rases*, records the history of a man who, being wounded by a ball in his heart, fell as if he were dead. Three months after, he suffered from severe palpitations, but which nearly disappeared after three years. At the end of six years he died of some malady in no way connected with the injury of his heart, and the ball was found lodged in the right ventricle, near its tip, and resting on the septum medium.

Perforating wounds of the chest which do not prove immediately fatal from the hæmorrhage—and it is upon these alone that our statistics of results are based—are still to be regarded as exceedingly dangerous. They are, however, much less dangerous than perforating wounds of the head or of the abdomen, and less so than those wounds of the chest in which the missile remains within its cavity.

It has been often observed that penetrating and perforating wounds of the chest and abdomen occasion, in a large proportion of cases, excessive nervous prostration or faintness, sometimes accompanied with nausea; in other words, that the patients suffer a "shock," although no large blood-vessels or important nerves may have been torn. Whatever may be the explanation in other examples, we are pretty well persuaded that in perforating and penetrating wounds of the lungs, unattended with hæmorrhage or nervous lesions, and when the admission of air has not caused the collapse of a considerable portion of the lungs, the apparent shock is generally due to the moral effect of the injury; since we have found it in repeated instances entirely absent in such cases, while it is quite as often present

in examples of non-penetrating wounds, but in which the patient has supposed the ball to have entered.

When a rib is broken at the point of entrance, the fragments may be driven in and made to penetrate deeply into the structure of the lungs; and the fact of the existence of a fracture at this point may, therefore, be regarded as adding much to the gravity of the prognosis; while a fracture at the point of exit is a complication of comparatively little moment.

An examination ought always to be made with the finger or probe to determine whether a rib is broken; and at the point of entrance a reasonable effort should be made to remove such loose fragments as may happen to be within reach. One of the most frequent causes of death and of delay in recovery is found to be small spicula of bone loosened or completely detached from a rib. This examination ought to have as its further object, the removal of any other foreign substance which may have chanced to lodge near the external orifice. Under almost no circumstances is it proper to introduce the probe or finger beyond the pleural cavity or into the substance of the lung itself. In most cases the collapse of the lung will effectually prevent such a procedure; but even when, owing to adhesions or other causes, collapse of the lung does not occur, an exploration of the track through the substance of the lung itself could only provoke hæmorrhage, and in many other ways add to the ultimate dangers.

The main trunk of each aortic intercostal artery lies, through a great portion of its course, in a small groove situated on the inner surface of the rib, and just above its lower margin, entering this groove near the angle of the rib posteriorly, and abandoning it not far from the sternum. If, therefore, the rib be broken completely off and driven

inwards, or if only its lower margin is broken, a rupture of this artery may be the consequence. It is quite probable that this accident occurs often, but being torn asunder rather than cut, it is very rarely that it gives rise to troublesome hæmorrhage. On the 2d of May, 1862, we saw at the General Hospital, at Fortress Monroe, under the care of Surgeon Cuyler, U.S.A., an example of rupture of this artery followed by severe and repeated bleedings. A large shot had lacerated the integuments pretty extensively on the left side of the thorax, exposing and fracturing two or three ribs. The surgeon had removed a portion of the rib beneath which the hæmorrhage had taken place, and tied the vessel; but the constant motion of the fragments during inspiration and expiration seemed to have worn through the coats of the artery again, and at the time we visited the hospital the bleeding was recurring at intervals; the wound looked badly, and the patient was so low as to afford very little hope of a final recovery.

In case the vessel can be found and separated from the adjacent tissues, it should be tied; if this cannot be done, continued pressure from within, made by the finger, the employment of a small pledget of lint saturated with the persulphate of iron and held against the artery in the same manner, may sometimes succeed, or the vessel may be twisted possibly, or secured by casting a ligature around the entire rib. If none of these measures are applicable or effective, the method pursued by Surgeon Cuyler, namely, exsecting a portion of the rib, and then tying the artery, would offer the best chance of success.

If the ball has perforated the sternum through its central portions, near the median line, an abscess in the anterior mediastinal space is almost inevitable; and it is worthy of consideration whether the trephine, by enlarging the ex-

ternal opening, and enabling the surgeon to remove some of the small spicula from within, might not diminish the subsequent dangers.

The symptoms which indicate that a ball has traversed a portion of the lungs, are, embarrassed respiration, sometimes a sensation of impending suffocation, expectoration of blood, the escape of air from the wound, or the extravasation of air underneath the integuments.

When several or all of these signs are present, and especially when there is added the fact of complete perforation of the opposite walls of the thorax, no opportunity is left for a doubt; but if, as sometimes happens, only one or two of these signs are present, the diagnosis may be rendered difficult. The respiration may be embarrassed in consequence of alarm, or of a severe concussion; a pulmonary bloodvessel may have been ruptured by a blow upon the walls of the thorax, and this is more especially liable to happen when a rib has been broken, although the ball has not penetrated; emphysema may be the result of a fracture and projection of a spiculum of bone into the pulmonary tissue.

The expectoration of blood in most cases occurs immediately—frequently not until after the lapse of several hours, or even days, but it is rarely seen after the fifth, sixth, or tenth day.

Isaac Etchell, a private in the 72d Pa., was wounded at Antietam, on the 17th of Sept., 1862, by a round ball, which entered the left side of the chest in front, three inches above and to the left of the nipple, passing completely through. He expectorated blood immediately and freely, but it soon ceased, and never recurred. On the 24th day the wounds had closed, and he was sitting up, but he continued to suffer from pain and a sense of oppression

over the whole of his left side. Having never seen him since, we are unable to state the final result.

Daniel Ryan, private, of the 70th N. Y. Vols., was wounded July 2d, 1863, at Gettysburg, by a rifle ball which passed through the left lower lobe of the lungs. This man expectorated blood freely at the moment of the receipt of the injury, and he continued to expectorate a little occasionally during the five following days, but not any since. Six months later, when seen at the General Hospital in Newark, under the care of Surgeon Taylor, U.S.A., a slight cough remained, but the wound had nearly healed.

Norton E. Hubbard, of the 6th Wis. Vols., was wounded at Antietam, Sept. 17th, 1862, by a rifle ball, which entered the chest in front on the left side, directly under the clavicle, and to the sternal side of the coraco-clavicular ligaments, passing through the chest, and escaping near the posterior angle of the scapula. It was found lying directly under the skin at this point, and was cut out by his surgeon. He expectorated blood at first very freely; but when seen on the 23d day, he informed us that he had had no bleeding since the first day. Some small fragments of bone, probably from the clavicle, have escaped in front. The wound was discharging copiously; he had a troublesome cough; his appetite was poor, and his chance for recovery seemed poor.

Moses Hazeltine, a private in the 12th Mass., was wounded at Antietam by a ball, which entered the thorax two inches outside of the left nipple, and passed entirely through the body. He expectorated blood within ten minutes, and continued to do so for nine or ten days. Air had escaped through the wound in the back. Suppuration was free on the 23d day; he had considerable cough, and was looking thin and pale.

At Boonsborough, Md., we were requested to see Lieut. ———, of the 27th Ind. Vols., who had been wounded twenty-four days before by a round ball, which perforated the chest and the upper lobe of the right lung. He expectorated blood at first, but not after a few days. The wound was suppurating, and his general condition not very promising.

At Middletown, Md., our attention was directed to Daniel Bowers, private, 19th Ind. Vols., who had been wounded at South Mountain, twenty-six days before. A round ball had entered on the left side, two inches outside of the nipple, escaping near the centre of the back, on the same side. He expectorated blood slightly soon after he was wounded. No grave symptoms ensued, and the wound was nearly closed. He said he was well.

At the battle of Cerro Gordo, Mexico, on the 18th of April, 1847, General Shields was wounded by a canister shot, which penetrated between the fourth and fifth ribs of the right side, an inch and a half or two inches from the sternum, and emerged between the sixth and seventh ribs of the same side, about one inch from their junction with the vertebræ. Surgeon Wright, of the U.S.A., who was in attendance, in order to arrest the flow of blood, applied a compress of lint, and subsequently sought to sustain him by stimulants, etc. Without entering more fully into the details of the treatment and the progress of the case, it is sufficient for our present purpose to state that he rejoined his command a few weeks after in its march towards the Mexican capital, during which he was engaged in several battles, in one of which he received a severe wound from an escopet ball in his arm. His recovery from the chest wound was complete; and he has ever since enjoyed perfect health. General Shields has commanded a Division

during the present war, and in the brilliant affair at Winchester, Va., in April, 1862, he was again wounded severely in one of his arms.

SECTION III.—PENETRATING GUNSHOT WOUNDS OF THE CHEST; OR THOSE IN WHICH THE MISSILE HAS ENTERED THE CAVITY OF THE THORAX, BUT HAS NOT ESCAPED. It may be assumed that the surgeon will never permit a case of this kind to pass without a careful examination, to ascertain, if possible, whether the ball may not be found. For this purpose, he will explore the wound cautiously with his finger or with a probe, bearing constantly in mind that if it has once fairly entered beneath the ribs, the chance of success is very small; and that he is, therefore, much more likely to do harm than good by a prolonged exploration. If it is in the pleural cavity, it has almost certainly fallen away from the point of entrance; and if it has penetrated the lungs, the change in the position of the wounded lobe will render it impossible to follow its track; nevertheless a certain number of rare and fortunate examples of success will warrant an examination, if it is properly made.

If the ball is not found at or near the wound, then an examination should be instituted to determine whether it is not under the skin at some opposite point of the body; and for this purpose the finger should be passed carefully over a large portion of the opposite surface, upwards and downwards, and to the right and left, for it is impossible to say how much it may have been deflected from its course.

If the ball remains fairly within the cavity of the chest, no doubt the prognosis must be very grave. Most of these patients sooner or later die, as a consequence of the irrita-

tion occasioned by the presence of the foreign body. McLeod says, that of thirty-three cases in which the ball lodged in the chest, or appeared to lodge, only two finally recovered.

The records of military surgeons furnish other examples of permanent recoveries after such accidents, and among them we remember to have seen it stated somewhere that the *post-mortem* examination of the body of Prince Jerome, who died a few years ago, led to the discovery of a ball which had remained in his chest after a duel which he fought in his youth with Marshal Davoust. McLeod mentions a case in which a ball became sacculated in the lower lobe of the lung, and although he died six months after the receipt of the injury, his death was not occasioned by the ball. Percy speaks of three similar cases; Mr. Arnot found the fragment of an iron hoop lodged in the lungs, which had been there fourteen years; and Boyer found a ball which had been lodged twenty years.

We will mention a few cases which have come under our own observation, accompanied with a brief notice of their results so far as we have been able to ascertain them. None of them have been traced through a very long period of time, but it will be seen that they do not generally give much promise of a final recovery:—

Willis R. Haley, 12th N. Y. Cav., wounded at South Mountain, Md., Sept. 14, 1862. The ball entered the back, on the right side of the spine, near the tenth dorsal vertebra. He expectorated blood very freely for about six hours, and had extensive emphysema over the back. We found him on the 26th day with an open, suppurating wound and considerable cough, but his breathing was unembarrassed.

Erasmus Doyle, 166th N.Y.V., wounded June 14th,

1863, in the famous charge upon the batteries of Port Hudson, Miss., made by General Sherman. He was in the act of charging up the hill, with his body bent forwards, when the ball was received. It entered just above the spine of the right scapula, penetrating the thorax. He spat blood more or less for eleven days, and air escaped freely from the wound. On the 6th of Dec., 1863, nearly six months after the accident, the wound was still open, and small fragments of bone were occasionally being thrown out. He had a troublesome cough, and his breathing was hurried.

Wm. H. Harris, 2d Wis. Vol., wounded at South Mountain, Sept. 14, 1862, by a ball, which entered the chest in front, one inch outside of the left nipple. It has never been found. He expectorated a small quantity of blood immediately, and this continued for three or four days. Air never escaped from the wound; his respiration and the heart's action have never been disturbed; he has had no cough, and on the 26th day, when he came under our notice, the external wound was entirely closed.

This case is so extraordinary in its results that we entertain some doubt whether the ball was not withdrawn by the clothing. It is possible, however, that it remains in the chest.

Ephraim Wood, private in Andrews's regt. of Sharpshooters, was wounded on the 17th of Sept., 1862, at Antietam. The ball entered on the right side, between the second and third ribs, two and a half inches from the sternum. He did not expectorate blood until the third day, and the bleeding never recurred. On the 23d day the wound was open and discharging. He had a cough; his respiration was embarrassed, and he looked feeble.

Edward M. Bliss, 15th Mass. Vol., wounded by a ball,

Sept. 17, 1862. The ball entered the right side of the thorax near the upper part, and has never been found. He raised some blood immediately, but none since. On the 24th day the wound was still open; he had some cough, but his general condition was very good.

Hugh Gallagher, 6th Wis. Vol., wounded at South Mountain. A ball passed through the right shoulder and entered the thorax on the right side. He expectorated blood immediately after the receipt of the injury, and several times subsequently. When seen on the 26th day, his expectoration was rusty, and his breathing somewhat embarrassed, but he was looking very well The wound had not closed.

J. Hard, 7th Wis. Vol., wounded on the 14th Sept., 1862, at South Mountain, by a ball, which penetrated the sternum, near the point where it unites with the right clavicle. The ball could not be found. He expectorated some blood, and on the 26th day the wound was still open. He had some cough, but his breathing seemed unembarrassed.

During the battle of Fair Oaks, on the 31st of May, 1862, Colonel Bailey's battery of six guns was posted on a slight elevation in the rear of the 96th, 98th, and 100th N. Y. Vols. The enemy was in the woods, a few hundred yards in front, and Colonel Bailey was compelled to fire over the heads of our own men. Our position, as Medical Director of Major-General Keyes's Corps, rendered it necessary that we should remain near the front until the ambulances came up; and we were able to see from where we stood the line of battle perfectly, and to note the fortitude with which, for more than two hours, General Casey's small division on the extreme front and left withstood the terrible assault which was made upon it. We mention

this because it has been said they did not fight well. The truth is, no troops ever fought better. The gallant Colonel Bailey lost his battery, but not until he had sacrificed his life. The whole of Casey's division did not at this moment amount to more than 3500 effective men, and of these, the reports made to us three or four days after, showed 233 killed, and 943 wounded—a total of 1176—but in addition, 669 were reported missing, most of whom it was afterwards ascertained were either killed or wounded, some being made prisoners. It is certain, therefore, that one-half of the whole number were either killed or wounded, and those of us who went over the field after the second day's battle, when we recovered the ground we had lost on the first day, will remember that most of these brave men lay in front where the line of battle had been first formed.

During the engagement, as we have said, Col. Bailey was firing over our own lines, and a part of the time the enemy was so near that the Colonel was compelled to use grape and canister. The grape was heavy enough to go over the troops fairly, but a good deal of the canister fell short. Very soon some wounded soldiers were brought in, who said we were killing our own men; and we were informed that at one point several were killed and wounded at one discharge. "The canister fell about like hail." Among those who were wounded in this way was Corporal George H. Williams, of the 98th N. Y. Vols. He was standing, he said, close up to a rail fence, and had not yet seen a rebel, when a canister shot entered his back, nearly opposite the middle of the base of the left scapula, between it and the spine, and passed into the left lung. He fell immediately, and was carried to the rear. For half an hour the blood escaped from the wound and from the trachea

freely; it then ceased spontaneously, and never recurred. The ball could not be found. The wound, which was very large, was dressed with lint and a roller.

He was subsequently sent to the White House, Va., and from thence to Annapolis. On the 3d of Sept., 1862, three months after the receipt of the injury, he returned to Yorktown, Va., where the writer was then stationed with Major-Gen. Keyes, to obtain his discharge. The ball still remained in his chest; the wound was open and discharging healthy pus; for some weeks past he had been annoyed with a violent and irregular action of the heart, which was much increased by exercise or mental excitement; he had some cough; there was dulness over the left lower pectoral region, yet his general appearance was very good. We have not heard from this man since.

In connexion with this subject we think it proper to speak of those metallic corselets or breastplates, and complete cuirasses, which have been furnished occasionally to the army by ingenious and humane artisans, and of which, we are happy to say, but few have ever been worn by either officers or men—at least so far as our experience goes. Some have been made of wire, we believe, and are composed of links, resembling the linked or chain armor worn by the knights and soldiers of olden times, before powder and guns were invented. These we have never seen in use. We have in our possession, however, two, made of plates of iron, hinged and bolted, which were worn in battle by officers during the present war; and, so far as we know, these are all that have been ever worn by persons of our acquaintance. One of them never felt a bullet until it was tried as a target, and after the owner had thrown it aside. The other was worn by a captain, and he was killed in the first severe action in which he was engaged. The

ball—a conical ball—entered the breastplate, near its upper and anterior margin, and perforating it, passed through the chest, severing some of the larger vessels. He was found upon the field dead. In this instance, the ball having struck the armor at a right angle with the surface, and at a short range, no protection was afforded.

Surgeon David Prince, the able and indefatigable Medical Director of Couch's Division of the 4th Corps, Army of the Potomac, reported to us, after the battle of Fair Oaks, that "in several instances bullets were arrested by breastplates." In one case a breastplate was penetrated by a minié rifle-ball, but its force was so nearly expended after perforating the metallic plate, that it merely entered beneath the skin; and then passing along superficially over the muscular walls of the abdomen, it was found lying beneath the integument upon the opposite side. This was on the person of Capt. ——, of the 1st Long Island Vols.

No doubt, these plates have firmness enough to turn aside missiles whose force is partially arrested, or which strike obliquely; but some of them protect nothing but the chest and a small portion of the abdomen, leaving many vital parts wholly exposed; and their little value, therefore, as a means of defence, is more than counterbalanced by their weight, which is not less than eight or ten pounds; and so long as swiftness of movement is the prime element of successful tactics and strategy, such cumbrous and imperfect armor can have nothing to recommend it to soldiers—certainly not to infantry, unless it be in Indian warfare, and where the enemy employs only the bow and arrow.

Further than this, we are of opinion that it demoralizes a soldier very much in the same way that too much fighting under the cover of breast-works is known to do. Troops accustomed for a long while to lie behind raised lines of

defence do not stand or charge well upon an open field. They exaggerate the danger; and an officer or soldier, one portion of whose body is securely protected, must be constantly reminded of those parts which are not at all covered. He never can acquire in battle that enthusiasm and perfect *abandon* which characterize the true soldier, and inspire courage and confidence into all about him. In short, we think, it will make him a coward, if he was not one before.

SECTION IV.—TREATMENT OF PERFORATING AND PENETRATING GUNSHOT WOUNDS OF THE CHEST. We have already indicated certain steps of the treatment, namely—the removal, as far as practicable, of all foreign substances from the wound; the ligature of bleeding arteries, etc; but other important considerations remain.

We may state in general terms that, in most cases, the wounds should be left open to allow of the free discharge of blood and of matter, only being covered lightly with a piece of lint wet with cool water. The patient should be kept very quiet for a few days, and as much as possible required to lie in such a position that the discharges will flow easily from the thoracic cavity through the wound; by which position, also, the opposing pulmonic and thoracic pleural surfaces will be approximated, and perhaps brought into contact near the track of the wound, and adhesion will thus be favored; a result which, if obtained, will diminish greatly the chances of an extension of the inflammation along the pleura, and probably prevent the occurrence of pneumo-thorax, hydro-thorax, or pyo-thorax.

With regard to posture, however, it must be understood that the patient will generally be obliged to consult chiefly his own immediate comfort in breathing.

If the patient suffers much from pain, or if he has a troublesome cough, opium or morphine may be given; and when inflammation begins to arise, cathartics and bleeding, with a rigid diet, may become necessary. In relation to agents of this latter class, employed for the purpose of lowering the vital forces, we need scarcely say that they are not always demanded; a large proportion, probably much the largest proportion of wounded soldiers whom we have seen, were in a condition requiring at first stimulation; and during all the subsequent progress of the case, requiring to be sustained by at least good, plain, nutritious food. Upon this point the surgeon must exercise a careful discretion.

Military surgeons have of late been generally agreed that in most cases gunshot wounds of the chest ought not to be immediately closed. This is in accordance with the general statement of our own views which we have already made. Recently, however, Assistant-Surgeon Howard, of the U.S.A., has recommended an opposite practice. He proposes, having first removed as far as possible all foreign substances, to hermetically seal the external wounds at once. In order to accomplish this more certainly, he pares away with a sharp knife the contused margins down to the bone or to the pleura, giving to the wounds an elliptical form; and then approximates the edges with silver sutures, which are introduced at very short intervals, and made to penetrate deeply; over the whole surface he now spreads collodion, in which the fibres of loosened charpie are imbedded to prevent more effectually the separation of the edges. A compress and bandage may be added if necessary.

Dr. Howard claims for this method that it will assist in controlling the hæmorrhage; that it will relieve the dyspnœa, and prevent or diminish suppuration.

It is perhaps scarcely proper to attempt a criticism of

these views at this moment, since the results have not yet been given fully to the profession. It will be proper, however, to state that this practice, in a form more or less modified according to circumstances, has been recommended and adopted in penetrating or perforating wounds of the chest made by sharp instruments; in all penetrating or perforating wounds of the abdomen whether gunshot or incised; and in all gunshot wounds of the chest accompanied with severe and alarming hæmorrhage from the pulmonic vessels. The novelty consists in the application of this method to *all* wounds of the chest; and it is precisely this exclusive view of the practice to which surgeons will hesitate to give their approval.

We will attempt to indicate what thoracic wounds seem to us to demand or permit immediate closure of their external orifices.

First.—All simple incised and punctured wounds; in which class of accidents ample experience has shown that we have not much to fear from suppuration, and that we may reasonably expect union by adhesion throughout the whole course of the channel caused by the weapon.

Second.—All wounds made by smooth round balls or shot, which have not come in contact with and broken any portion of the bony parietes, and into which no foreign substance has been conveyed.

Third.—When both pleural cavities have been opened by the weapon or the projectile; since the free admission of air into both sides of the chest would, in most cases, cause death immediately, and it is proper to anticipate and provide against such an occurrence by every possible means.

Fourth.—When the pulmonic hæmorrhage—the blood escaping freely from the external orifices—is very profuse and alarming. In closing the wound, under these circum-

stances, the purpose would be to allow the blood to accumulate within, with the hope that eventually, and before fatal syncope was induced, the pressure of the coagulated mass upon the wounded lungs would close the vessels. In this case, however, the wound should not be closed by sutures, but with compresses and adhesive straps, in order that, if the pressure of the blood became so great as in itself to threaten death by suffocation, by removing the dressings it might be allowed again to escape.

Fifth.—When it is ascertained that the sense of suffocation is due to the presence of air in the pleural cavity and not to blood; if at this moment the external wound is open it will be proper to close it, temporarily at least, and to keep it closed so long as the breathing is thereby relieved.

The cases which remain after this enumeration, and in which we cannot from our present experience advise a closure of the wound, are:—

First.—Gunshot wounds made by conical rifle-balls, and by all projectiles of a larger size (with the exceptions as to pneumo-thorax, pulmonary hæmorrhage, and perforation of both cavities already stated).

Second.—Gunshot wounds made by any form or size of projectile, in which fragments of bone or other foreign substances have been sent into the cavity of the chest and cannot be removed.

Third.—"Penetrating" gunshot wounds, or those in which the missile itself remains within the chest.

In not one of these latter cases would it seem proper to hermetically seal, or even close temporarily, the external orifices. The very rare examples of recovery from such injuries, without excessive suppuration, do not warrant a reasonable expectation of a result so desirable.

A large majority of those who have died after the lapse of a few days or weeks, from gunshot injuries of the chest, are found to have considerable collections of pus within the pleural cavities, or in the structure of the lungs; and these collections appear frequently to have been the immediate causes of death. If closing the external wound over the contused and ragged track of these larger missiles, often made more ragged by spicula of bone, shall be found to diminish the frequency and fatality of these thoracic abscesses, the profession and the world will be greatly indebted to Dr. Howard. This is what we understand him, among other things, to claim for his plan of treatment, and we shall wait for the result of his observations with the most profound interest.

Since writing the above we have been permitted to see two cases, at Fredericksburg, Va., after the battles of the "Wilderness," which had been hermetically closed by Dr. Howard, in both of which the wounds had nevertheless refused to unite by first intention.

These are the only cases which have yet come under our notice.

It is the general opinion that when a free opening is made into either of the pleural cavities, the lungs will immediately and completely collapse. It is certain that this will always happen in case the opening is made after death and no adhesions exist, and the lungs themselves are not congested; but Mr. Guthrie has not found this to occur to anything like the same extent in the living body. This latter observation has been repeated by Williams, Hennen, South, McLeod, Longmore, Ballingall, and Gibson. The lung, under these circumstances, it is said, can be seen in motion and performing its office, although imperfectly, as it does not fill completely the cavity of the pleura.

These gentlemen declare that this is a common experience, even when the lungs are not fettered by adhesions. They do not, however, inform us that in any of their cases autopsies have been made to confirm their statements of the non-existence of adhesions, and it does not appear clearly how the condition of the pleural cavity in this respect could be otherwise ascertained. Their purpose in making these statements is to correct what they regard as a popular error, and to justify the opening of the chest and the free admission of air in certain cases of dyspnœa.

We do not find it difficult to conceive that in case one side of the thorax preserves its integrity, a small portion of air may pass at each act of inspiration into the interior of that lung whose pleural cavity is open. The column of air, entering through the trachea during the expansion of the sound lung, will be divided at the bifurcation of the trachea; and a small portion, in consequence of the momentum it has acquired, will be driven into the lung upon the opposite side; sufficient, perhaps, to cause a sensible motion in the lung of this side, but not sufficient for any useful purpose in the maintenance of life.

We can also understand that if the opening in the pleural cavity is smaller than the opening of the glottis, air will not be admitted, during the act of inspiration, into the pleural cavity as rapidly as into the air cells of the lung, and that consequently the motions of the lung will follow, in some measure, the motions of the ribs; but inasmuch as it is probable that, at each inspiration, more air will enter through the wound than will be discharged in expiration through the same orifice, this coincidence of motion between the lung and the thoracic parietes will soon cease; in other words, the lung will, after a time, collapse.

These are the only explanations of these phenomena

which seem admissible; and, in either case, we could not expect the maimed organ to be of any particular service, at least for any length of time, in the decarbonization of the blood. Certainly no one will maintain that both pleural cavities could be freely opened where no adhesions existed, and life be prolonged beyond a few seconds, or minutes at most. The few examples of recovery after perforating wounds of both sides of the chest which some of these surgeons have recorded, were, no doubt, examples in which either the wounds were not sufficiently open to admit the air, or the natural cavities were in part obliterated by adhesions.

Mr. Guthrie, whose opinions we have quoted, has not been sufficiently clear upon this point; for, while he admits that opening both cavities simultaneously has proved "almost instantly destructive to life," he affirms that, where an opening is made into the cavity of the chest in the living body, collapse of the lung does not take place in anything like the same extent as in the dead body; and that, to cause complete collapse of a living lung, its surface must be *compressed* by a fluid or by confined air.

We will not affirm that Mr. Guthrie is wholly incorrect in his general statement of the facts, but we believe that in no case will the lungs, under the circumstances supposed, expand sufficiently to answer any useful purpose; and that, just as certainly as we shall destroy the functions of both lungs when we open freely both pleural cavities simultaneously, just so certainly shall we seriously maim, if we do not actually destroy, the function of one lung, when we open freely its pleural cavity.

We are now prepared to consider the circumstances which may render it necessary to re-open the wound, or to make a new opening at some other point of the thoracic cavity.

First, in certain cases of hæmothorax, the patient, being threatened with suffocation in consequence of the great accumulation of blood within the pleural cavity, will be relieved by the evacuation of the blood and the substitution of air. We say substitution of air, because it is manifest that we cannot evacuate the blood without admitting the air freely at the same moment. Those who have recorded examples of relief afforded by this operation in these cases, have not properly explained its rationale. The explanation which we propose to offer is, that air which is allowed to pass in and out freely through the external opening, can do no more than cause a collapse of one lung; and, indeed, we have seen that this collapse has not been always found to be complete; but blood imprisoned may accumulate until, by its pressure, it causes not only a complete collapse of the lung upon the wounded side, but it may finally displace the mediastinal septum to such a degree as to impair seriously the function of the opposite lung, and even of the heart itself.

We shall be able to determine the existence of hæmothorax by the steadily increasing signs of exhaustion, such as a feeble pulse, extreme pallor, faintness, etc.; by the occurrence of these symptoms during the period when bleeding is most likely to take place, namely, the first few days after the accident; by auscultation and percussion. The blood will usually at first occupy the most depending portions of the cavity, and there will be more or less dulness, with absence of the natural vesicular murmur. If the amount of blood accumulated is excessive, there will be present also a feeling of weight, the patient will be inclined to lie upon the affected side, the intercostal spaces will fill up, the action of the heart will become irregular, and finally all the signs of dyspnœa will supervene. (Sabatier has,

however, seen patients die of concealed thoracic hæmorrhage in whom dyspnœa was not present, and the patient could lie upon either side without inconvenience.) If the wound is open, and especially if it is at a depending point, blood may be seen to flow, or clots may project from the orifice.

To these indications of the effusion of blood within the pleural cavity Valentin has added ecchymosis, commencing about ten days after the receipt of the injury or even later, and which presents itself first near the angles of the lower or false ribs and extends downwards into the loins. This ecchymosis is unaccompanied with swelling or tenderness, and is of a bright violet color, being identical in this respect with that which appears on the abdomen some time after death. This phenomenon, however, must not be regarded as absolutely pathognomonic, since it is not always present in hæmothorax, and occasionally the same ecchymosis is observed after wounds which have not entered the cavity of the chest.

Let it be understood that upon the closure of the wound the surgeon depends very much in these alarming examples of internal hæmorrhage to arrest the bleeding, and that nothing but impending suffocation will justify its being re-opened. This operation is to be deferred, therefore, to the latest moment; and then, in order to give effectual relief, the opening must be made free, and, in case it is deemed advisable to make a new opening, it will be well to select the most depending point of the thoracic cavity.

Second.—While it has been found necessary sometimes to open the thorax in threatened suffocation, in order that the blood may be evacuated and air substituted, on the other hand cases have occurred in which air alone, accumulated and imprisoned in the pleural cavity, has threatened

death by suffocation, and relief has been afforded by an operation.

This seeming paradox is of easy explanation. It will happen sometimes that the wound through which the air is admitted into the pleural cavity, whether this wound communicates with the bronchial tubes or the outer surface of the chest—it will happen occasionally, we say, that this wound will be so constructed, being oblique or having something of a valvular arrangement, as that the air will be admitted readily, but it will escape with difficulty. There will be an action like that of a force pump; and after a time the air may accumulate to such a degree as not only to compress the lung upon the wounded side, but it may, as in the case of accumulated blood, displace the mediastinal septum and compress the opposite lung.

Relief now will be afforded by an incision which will allow the air to pass in and out with equal freedom.

The signs of pneumothorax are the absence of the respiratory murmur, tympanitic resonance, occasionally metallic tinkling, decubitus on the affected side, increase in the circumference of that side of the thorax, elevation of the intercostal spaces, and finally displacement of the heart, compression of the opposite lung, and excessive dyspnœa. In attempting a diagnosis, the surgeon should be careful not to confound a tympanitic resonance, due to intestinal and gastric inflation, with that which may be due to the presence of air in the cavity of the pleura.

The operation for the relief of pneumothorax consists in enlarging the original wound, or in making an opening with a trocar and canula at any point which may be most convenient.

Third.—Hydrothorax, as a result of gunshot injuries, may demand the reëstablishment of the external opening.

Serum may be effused into the pleural cavities as early as the third or fourth day after the receipt of the injury; and in a few days more the accumulation may be sufficient to occasion serious embarrassment to the respiration. Its presence is recognized by those general signs which indicate the accumulation of any fluid within these cavities, namely, decubitus upon the affected side, enlargement of the circumference of the thorax, projection of the intercostal spaces, absence of respiratory murmur, dulness on percussion, etc.; but it is distinguished from hæmothorax in being preceded usually by the signs of pleuritis or of pleuro-pneumonia, in the absence of those symptoms of prostration which must necessarily accompany large bleedings, and in the greater facility with which the contained fluid flows from one point of the cavity to another on change of position.

If the original opening has completely closed, it will be proper to select a new point for the operation, and one which is sufficiently depending to secure the free evacuation of all the fluid. In general the operator will prefer the upper margin of the seventh rib, at a point near the junction of its posterior and middle-thirds.

The serum found in the pleural cavity under these circumstances is generally more or less mingled with blood; and, if the operation is made as late as the tenth or twelfth day, it may contain both flakes of lymph and pus; but its fluidity is such usually that it will not require a large opening for its evacuation.

It is desirable, if possible, to prevent the admission of air in all cases in which we operate for hydrothorax.

Military surgeons do not all assent to this doctrine Some have observed that air does not directly influence serous surfaces and they can see no harm in allowing it

free ingress; but air certainly promotes decomposition of blood, pus, and probably of serum also, and converts them from bland, unirritating fluids into ichorous and scalding discharges. When blood, serum, or pus is present, therefore, it would be fortunate if the air could be excluded. We have seen that this cannot be done when we operate for hæmothorax, since a small opening would be insufficient to evacuate those large clots of blood. In traumatic hydrothorax, however, the fluid may in general be evacuated by a trocar and canula, and with judicious management the admission of air can, in many cases at least, be prevented.

There is another reason why we would avoid the admission of air after this operation. We resort to tapping in hydrothorax not alone for the purpose of relieving the dyspnœa, nor, indeed, mainly for this purpose; but in order that we may, by a timely removal of the pressure upon the lung, prevent the formation of those adhesions which will very soon bind it against the posterior wall of the thoracic cavity, and impair, if it does not destroy, its function for ever. In short, we remove the fluid in order that the lung may resume at once its normal position, and in the hope that by contracting adhesions over the whole of its peripheral surface, we may effectually secure the patient against any similar accumulations hereafter.

Having removed the fluid, and closed the wound hermetically, the patient should be directed to lie upon the injured side, so that the lung shall be made to fall, if possible, against that side of the chest; by which means adhesions between the pleura-costalis and pleura-pulmonalis will be favored.

Fourth.—The chest must be opened when pus has formed within the cavity of the pleura. The signs of pyothorax

(empyema) are the common signs which indicate the presence of any fluid in this cavity, occurring in most cases at a later day than in either hæmothorax or hydrothorax, preceded by pleuritis or pleuro-pneumonia, accompanied with rigors, night sweats, and all the usual phenomena of hectic; the intercostal spaces are more frequently obliterated, and the cellular tissue of the dorsal and lumbar regions is sometimes œdematous.

The existence of pyothorax having been fully ascertained, no time ought to be lost in giving to the pus a thorough evacuation, either at the wound, or, in case this is completely closed, at the most depending point of the thoracic cavity.

What has been said in relation to the admission of air in cases of pneumothorax, is equally applicable to the pathological condition we are now considering. Air rapidly decomposes the pus and renders it offensive, acrid, and irritating; and by the admission of air, also, the lung is not permitted to expand upon the removal of the pus; and permanent disability of the lung, with contraction of the thoracic wall, is inevitable.

In idiopathic pyothorax, employing the term idiopathic in contradistinction to traumatic, and in examples of traumatic pyothorax, the result of incised or punctured wounds—in none of which cases is there probably any foreign substance, such as pieces of clothing, fragments of bone or of bullets, within the cavity of the chest to perpetuate the discharge—it is of the highest importance to exclude the air. This is not always practicable, since the opening, however carefully made, is exceedingly prone to become fistulous, and not unfrequently the flakes of lymph so block up the channel that nothing but a free opening will answer. There are many surgeons and physicians, also, who do not

regard it as a matter of any moment whether the air is admitted or not. These opinions have become especially prevalent of late; and, in proof that it is just as well to admit the air as to exclude it, they who entertain these opinions refer to many examples of recovery after free incisions. It is not, however, entirely a question of life to the patient which we are considering. The essential purpose which the surgeon has in view in excluding the air is to give the lung an opportunity to expand, and thereby to restore its function; and it is probable that this never happens to any great extent when the orifice remains permanently open until the cure is completed.

It is perhaps hardly worth while to discuss this point so important, as we think, in its relations to pyothorax, as it occurs usually in civil practice, and as it results from punctured wounds in battle; since, in the empyema which results from gunshot wounds, the admission of air, if it has not already preceded the operation, becomes almost inevitable after the operation, from the fact that the formation of matter is so persistent; the orifice made by the operator sooner or later becoming an established and open fistula.

Moreover, in a very large proportion of these cases, there remain some small spicula of bone or other foreign substances, whose escape would be favored by allowing the wound to remain open. It will be seen, therefore, that, excluding those examples in which it is found impossible to keep the wound closed, and also those in which it is not desirable to keep it closed, very few cases will remain to which the rule can be properly applied. In short, we shall only attempt to exclude the air after the operation when it is known that there is no foreign substance within the chest, and even then a failure must generally be anticipated.

In order to facilitate the escape of a foreign body which

lies loose in the cavity of the thorax, the orifice needs to be large and in a proper situation. If its exact position becomes known, and it cannot be reached otherwise, the surgeon will not, in general, hesitate to make an incision for its removal. The sooner it is removed the better, because its continued presence will perpetuate the discharge, and because every day the intercostal spaces are becoming diminished by the contraction of the side of the thorax, until at length, in some cases, the ribs nearly meet, and a free opening into the chest could then only be made by the removal of a portion of one of them.

When air has once been admitted, in a case of pyothorax, we fully believe that thereafter the wound should remain open; and the larger the orifice the better it will be for the patient. It is probable that a very small amount of air admitted will insure decomposition of the pus as certainly as a larger amount; and when decomposition has commenced, it is neither possible nor desirable to maintain occlusion.

We shall observe now, that the patient never fails to experience an increased difficulty in respiration, and that most of his other symptoms are aggravated whenever the wound is temporarily closed, and that he is relieved the moment it is opened again.

The process of cure in pyothorax is slow, tedious, and too often, unfortunately, ends in hectic and death. There are several causes which may operate in causing this delay.

The bullet sometimes perpetuates the suppuration; a piece of cloth is occasionally left in the track through which the bullet has passed; very often small fragments of the ribs, of the sternum, or of the scapula have been carried in. To these causes we may add at first incessant motion of the ribs in the act of respiration, which in some

measure prevents adhesion even when the surfaces come in contact; but especially the collapse of the lung, in consequence of which an enormous cavity is left, upon which the ribs and diaphragm contract only slowly, and a portion of which has to be filled up with granulations and layer after layer of fibrin, the lung itself, in most cases, only expanding again to a very limited extent, and after the lapse of many months, or even years.

It is plain, therefore, that the great object of the surgeon must be to allow the matter free egress, and to sustain the general system. Never for a single day ought the abscess to be closed, lest the confined matter, finding no other way of escape, should penetrate the walls of the thoracic cavity, and make channels for itself in other directions. When once the pus has found a way into the cellular tissue outside of the pleura, no limits can be given to its aggressions, and a speedily fatal issue may fairly be anticipated. In very many of the autopsies we have seen the pus burrowing deeply among the muscles of the back, underneath the peritoneum, and down even into the pelvic cavity.

As to injections, it is probable that when employed solely for the purpose of insuring cleanliness in the abscess, they will always be of some service; and then tepid water, or tepid water slightly medicated with such disinfectants as the chlorines or the bromides, will answer the indications fully. The fluid should be conveyed into the abscess in the most gentle manner; and then, by turning the patient upon the wounded side, it should be poured out again, in the same manner that we would proceed to rinse out a cask through its bung-hole.

Surgeon Middleton Goldsmith, U.S.V., has employed for this purpose a solution of bromine and bromide of potassium with excellent effects, the proportions being the same

as used by him in cases of hospital gangrene. We have ourselves witnessed the advantages of this solution in cleansing the abscess, removing the fœtor, and giving comfort to the patient.

If the orifice cannot otherwise be kept freely open, it should be dilated by the daily introduction of conical gum-elastic tents or sounds, or with tents made of a piece of the bark of the slippery elm tree, which rapidly swells by the absorption of moisture, and which the patient, after a little instruction, will learn to use himself.

The only form of emphysema which deserves special attention in this place is the traumatic variety, and in which the air has been admitted into the areolar tissue underneath the skin.

This phenomenon is quite common after simple fractures of the ribs, when the points of the fragments have penetrated the structure of the lungs; in our recorded notes we find it noticed in eleven cases out of twenty-one; but in gunshot fractures it has happened to us to meet with it much less often. When a rib, being broken, is made to penetrate the structure of the lungs, and at the same time there is no wound upon the surface communicating with the cavity of the pleura, the air admitted into this cavity from the bronchiæ in the act of inspiration, is driven outwards through the wound in the pleura-costalis during the act of expiration, and now readily passes into the areolar tissue underneath the skin. If, however, the wound in the pleura-costalis communicates freely with the outer surface of the integument, the air escapes externally and no emphysema takes place. Emphysema is produced by the contraction of the thoracic parietes, and not by their expansion; and it follows that the air which causes this phenomenon must come directly from the pleural cavity, and this,

too, notwithstanding it may have entered the cavity originally through an external wound.

This explanation, as applied to its occurrence in simple fractures unattended with any external wound, is sufficiently simple; but it is not so easily understood how it can happen in compound fractures, where there is an external wound, made perhaps by a bullet, communicating with the cavity of the pleura.

We presume it happens in this way:—Occasionally the wound through the walls of the chest is oblique, or the muscles through which the missile has passed subsequently change their position, and thus a complete valve or diaphragm is formed, which effectually prevents the escape of air without, and turns it aside into the areolar tissue. It is observed, accordingly, that emphysema is much more likely to occur when the wound has been made through the larger muscles which cover the thorax, such as the pectoral, latissimus dorsi, the serratus major anticus, etc. It seldom ensues when the injury is received in portions of the chest less thickly covered; and it never occurs to any extent when the external wound is very large.

The symptoms which characterize traumatic emphysema are at first a very moderate and diffuse swelling in the vicinity of the wound, unaccompanied with pain or redness, but especially is it recognized by a peculiar crackling or crepitus when the finger is pressed gently upon the part. In most cases this emphysema is limited to the space of a few inches, and need cause no anxiety. Occasionally, however, it continues to extend, until the integuments in every part of the body, except the soles of the feet and the palms of the hands, are enormously distended, and all the original contour of the body is completely lost. Finally, the air may find its way into the mediastinal space, and even into

the structure of the lungs, and cause death by actual suffocation. A very few such extreme examples have been recorded, but they are too rare to warrant a just apprehension of a similar result in any case. We have once, in a case of simple fracture, found the emphysema as low as the middle of the thighs, and involving the whole of the neck and head, with portions of the upper extremities, but there was no embarrassment in the respiration which could be properly traced to this cause. In all the other examples seen by us, the emphysema has not covered more than a few inches, or has at least not extended beyond the chest and lower part of the neck.

In no instance which has come under our notice has the emphysema demanded any treatment whatever. Ordinarily it has disappeared completely in from two to four weeks; and, in the case where the extravasation of air was most extensive, involving four-fifths of the whole body, it passed away in five or six weeks without either surgical or medical interference.

If, however, the symptoms become more alarming, it will be proper to enlarge the external opening, and to tap the integuments at various points of the body, and especially over those parts in which the pressure of the air is causing interference with vital functions.

Hernia of the lungs is a very rare accident, especially as the result of gunshot injuries. We have met with it once in the person of a soldier wounded at the battle of Fair Oaks. Our attention was called to him the night after the second battle by one of the surgeons. He had been wounded by a ball on the left side of the thorax, a little below the nipple. The ball had not been found. He was lying upon the ground in a condition of considerable prostration. The hernia was about one inch in diameter, hav-

ing escaped from an aperture which was very much smaller. It was completely strangulated, being quite black and insensible to the touch. We applied to the neck of the hernia a strong silk ligature, for the purpose of expediting its destruction, and then made fast the ends of the ligature to the outer surface of the chest by adhesive plasters, to prevent the escape of the ligature within the cavity, in case the hernia should retire after it had sloughed. We saw this poor fellow the next morning lying in the same place. He had taken a little nourishment, such as we had to give him, and expressed himself as being comfortable, although he had lain without shelter two nights, and during each night he had been drenched with rain. In this respect he suffered, however, only in common with at least two thousand other wounded and dying men. We cannot omit this additional tribute to the bravery of these noble fellows. During all this time—and we were with them every moment both night and day—there was never heard one cry of impatience or one murmur of complaint beyond that which was extorted by the agony of suffering.

When the wounded were sent down to the White House this boy was sent with them, and we have never seen or heard from him since.

There are two forms of hernia of the lungs: one occurring immediately or very soon after the accident, while the tegumentary wound is still open, and in which the protruded lung has no covering; the other being formed at a later period, after the external wound has cicatrized, and which is covered by fasciæ, integument, and pleura.

The first of these, namely, that which takes place immediately or soon after the accident, is caused by the contraction of the walls of the chest before the lung has collapsed. It is most likely to happen, therefore, immediately upon

the receipt of the injury, and especially if at this moment the patient attempts to cough; preceding which act the glottis is closed, and the walls of the chest are firmly contracted upon the air contained in the bronchial tubes. Adhesions favor the occurrence of hernia, provided they are a little remote from the seat of the wound; and it is more likely to occur when there is a small wound than when the wound is large, for the reason that in the latter case the prompt admission of air into the pleural cavity causes the lung to recede. It is much more common, therefore, to meet with hernia of the lungs in bayonet and in other punctured wounds than in gunshot wounds. Its existence also generally, but not always, implies that the structure of the lungs is not wounded. Malgaigne even thinks that it is just as likely to occur when the lung has collapsed. The vascularity of the lung is such that, when strangulated, it speedily assumes a dark purple color, and, possessing but little sensibility, its condition leads at once to a suspicion that it is actually dead, while its vitality may be only slightly impaired. Its death can only be affirmed when its sensibility is completely lost, when its purple or brown color has changed to black or grey, and its tissue is softened by the commencement of the process of disintegration.

The occurrence of a hernia of the lung, accompanied with strangulation, may be regarded as a serious accident, since it is scarcely possible that the inflammation will not be propagated from this point to other portions of the lung; but on the other hand, if properly treated, the patient is by this accident made secure against a collapse of the lung, and he is in less danger of pleuritis, and of the consequent pleuritic effusions.

If the hernia has just taken place, and there is no stran-

gulation of any moment, no doubt the surgeon ought to attempt its reduction at once by the most gentle pressure; in which effort he might be aided, perhaps, by instructing the patient at the same moment to make a very full inspiration. If this fails, the opening should be carefully enlarged, using for this purpose a grooved director and a probe-pointed bistoury. It is scarcely possible for such herniæ to take place except when the muscular coverings are thin; and as it is in general only the fibres of the intercostal muscles which have to be severed, the surgeon will bear in mind their direction, so as to make their *debridement* complete. The delicacy of the structure with which we have to deal, and the fact that the lung is in actual contact with the pleura-costalis at the point where the strangulation is to be relieved, exact on the part of the operator the greatest care and delicacy of procedure. It is far better that the strangulation should continue than that the lung should be returned after having been bruised and lacerated.

Guthrie says three cases were brought to him after the battle of Waterloo, and that, in pursuance of his advice, none of them were interfered with. Without stating the results more particularly, he declares that this proved "greatly to the advantage of the patients."

It would seem, however, if the hernia is to remain, and its separation by ulceration or sloughing is inevitable, that the more speedily this could be accomplished the better, and that, while it might be improper, owing to the vascularity of this tissue, to remove it by the knife, it would be eminently proper to destroy it at once and completely by the ligature, as was done in our own case. Yet we ought to say that Legouest and Guthrie recommend that it shall be left to take care of itself, only giving it such protection as may be necessary to prevent its being irritated or chafed.

The second form of hernia is that which, occurring at a much later day after the accident, or without any previous wound of the parietes, is covered by integument, fasciæ, and pleura, and which seldom if ever becomes strangulated. Indeed this form of hernia, even more rare than the first named, and unattended usually with serious consequences, only deserves mention in order that the surgeon may be warned of the possibility of mistaking it for pyothorax. If a doubt exists, the diagnosis can always be easily made out by a resort to auscultation.

This secondary hernia is produced in most cases by a mere contusion of the walls of the chest, which has resulted after the lapse of several months in the almost complete absorption of the muscular parietes over the seat of injury.

ADDITIONAL CASES OF GUNSHOT INJURIES OF THE CHEST.

CASE I.—*Illustrating the serious consequences which may ensue from simple concussion of the Thorax, namely, hæmoptysis, pneumothorax, and pyothorax.*—Michael Macklynn, aged 46, was struck by a shell on his back, at the battle of Gettysburg. The blow was received on the right side of the spinal column, between it and the base of the scapula. The skin was not broken, but a dark red discoloration remained. He was thrown down, and for a few moments was unconscious. Blood came from his mouth freely, and he continued to spit blood during two or three days. On the third day he experienced a good deal of pain in that side of the chest, and began to cough. These symptoms, no doubt, announced the accession of pleuritis. About three weeks from this time he suddenly felt as if something had given way in his back, the sensation being accompanied with pain and soreness. By the courtesy of Sur-

geon Clemens, U.S.A., in charge of the Central Park General Hospital, New York, we were permitted to examine this patient on the 13th of March, 1864, nearly nine months after the receipt of the injury. He was looking rather feeble; his cough was severe, and accompanied with a copious purulent expectoration. During the act of coughing, air, mingled with a fluid, could be heard rushing out through an opening in the back of his chest, and it could be seen to form a broad and slightly elevated tumefaction under the integument. It is probable that matter had formed in the right pleural cavity, and after having first penetrated into the bronchial tubes, it at length made its way through the pleura-costalis; in this direction it was gradually approaching the surface.

Case II.—*Round musket ball turned aside by the ribs.*—George C. Flanders, 20th Mass. Vols., wounded at Antietam by a round ball, which entered the right side, just above the nipple, and passed out on the back near the inferior angle of the scapula, having made a circuit of one-fourth of the circumference of the thorax. This man came under our observation at Frederick City, Md., twenty-three days after the injury was received, and he informed us that he never expectorated blood, that he had had no cough, and in short that he had experienced only the most trivial inconvenience from the wound. The orifices were still discharging pus, but he seemed well.

Case III.—*Round musket ball turned aside by the ribs.*—Norman Johnson, a private in the 1st Michigan Infantry, received on the 21st of July, 1861, a round ball upon the right side of his thorax, three inches below the centre of the clavicle, which, glancing off from the ribs, was found under the integuments, upon the anterior aspect of the arm, four inches below the acromion process. The ball having

been removed by Surgeon Joseph R. Smith, at the Seminary Hospital, in Georgetown, we found him on the ninth day without any thoracic symptoms, and apparently doing well.

Case IV.—*Slugs not penetrating the walls of the Chest.—Embarrassed respiration.*—On the 3d of Oct., 1862, Tony Rice, a private in the regiment called "Les Enfans Perdus," was shot near Yorktown, Va., by a gun loaded with small slugs, each of about the size of a buckshot. We counted seven wounds on various parts of his body, several of which were upon his chest. None of them had passed entirely through, and it was apparent that none had fairly entered the thoracic cavity. He had no bloody expectoration or cough, but at first and for several days he breathed with difficulty, owing, no doubt, to the injury inflicted upon the muscular parietes.

Case V.—*Wound of the Lungs by a round ball, without bloody expectoration.*—Wm. Lathrop, private, of the 12th N.Y.V., was wounded at the battle of Blackburn's Ford, July 18, 1861, by a round ball, which entered the outside of the left shoulder, and passing through the left lung, escaped upon the back on the right side of the spine. We saw him on the same day, and found him pale, suffering severely from the shock; the wound on his back was discharging a little blood of a light scarlet color, and air was passing in and out freely, but he had not yet expectorated any blood. The wound was dressed by Surgeon Palmer, U.S.V., with a compress of lint, wetted in cool water. On the 20th we saw this man again. His condition was considerably improved, a fair reaction having taken place, but up to this moment he had not expectorated blood.

Case VI.—On the same occasion also we examined private Oakden, of the 12th N. Y. Infantry, who had received

a ball, probably a round ball, between the seventh and eighth ribs, and which remained within the cavity of the chest. In this case our attention was called also to the fact that he did not expectorate blood.

It will be noticed that in both of the above examples there were reasons to believe that the ball was round and smooth.

CASE VII.—*Perforating wound; round ball; speedy recovery.*—A. W. Burnham, 2d N. H. Infantry, wounded at Bull Run, July 21, 1861. The ball entered on the right side of the chest, in front, and passing through the lung was found under the integuments of the back. It was removed by his surgeon, and dressed with lint wetted with cool water. He expectorated blood freely immediately after the wound was received. This man, whom we saw in the hospital at Alexandria ten days after the battle, was doing well, and at the end of five weeks he was discharged cured.

CASE VIII.—*Pistol ball through the cavity of the Chest, and rapid recovery.*—Michael Shaler was shot by a pistol ball on the 17th of April, 1855, the ball entering between the fifth and sixth ribs, a little to the right of the sternum, and passing out at a point directly opposite on the back. Soon after he was wounded he spat a very little blood, but there was no bloody expectoration after this. His breathing was at first somewhat embarrassed, and he looked pale and alarmed. The wound was dressed with a compress wetted with cool water, and he was placed moderately under the influence of morphine. Very little inflammation of either the lungs or pleura followed; nor did any other accident delay his recovery. On the first of Sept., 1855, a little more than four months after the injury was received, he declared that he was in the enjoyment of perfect health.

Auscultation and percussion gave no indications that the lungs had suffered any lesion.

CASE IX.—*Perforating wound of Lung followed by pyothorax.*—Melchior Breitel, private, 12th N.Y.V., was wounded at the battle of Chancellorsville, by a conical ball, which entered the lower lobe of the left lung, and was found beneath the integuments of the opposite side, having broken the seventh rib near the sternum, at the point of exit. Eight months afterwards we found the rib necrosed, and the wound still discharging pus. Several fragments of bone have escaped from time to time. His breathing was unembarrassed, and his general health good.

CASE X.—*Perforating gunshot wounds resulting in pyothorax, etc., complicated with six additional wounds in various parts of the body.*—James Brownlee, a private in the 124th N.Y.V., 11th Corps d'Armée, was wounded at the battle of Gettysburg on the 1st of July, 1863. The wound in his chest was made probably by a conical ball, which entered the sternum about one inch below the top, and, passing downwards and outwards underneath the second, third, and fourth ribs, perforated the upper lobe of the right lung superficially, and escaped between the fourth and fifth ribs upon the same side, about three inches to the right of the nipple. The third and fourth ribs were broken, probably by the ball. In his opinion, however, they were broken when he fell. The bleeding from the wounds was free, but whenever they were closed blood flowed from the mouth. Three buckshot took effect above the pubes, some of which passed through the bladder. One ball entered the right thigh, and has never been removed or found. A conical ball entered the left thigh, and passing nearly through, was removed by a surgeon on the fourth day. A nearly spent conical ball struck upon the back of his

sacrum, near its middle, and buried itself slightly beneath the skin, and was pulled out by himself immediately. This brave fellow received in all four balls and three buckshot. The wounds have all, with the exception of the chest wounds, healed completely, but the scars remain to confirm the accuracy of his statements.

In addition to all this, Brownlee affirms that he was finally struck on his back, the blow being received directly upon his knapsack, and knocked down, by a piece of railroad iron about eighteen inches in length, which was discharged from one of the enemy's guns. He says he saw the piece of iron as it was falling, and tried to escape from it, but did not succeed. Having been made a prisoner also very soon after, he observed that the railroad iron was taken up from the track, and, as he believes, for the purpose of breaking it into fragments to be used in the guns. We are also informed by a sergeant, that at the battle of Chancellorsville he dug from the earth a piece of railroad iron which the enemy had thrown, and which, striking a rail fence, upon which an officer was sitting, knocked down both the rail and the officer, and then buried itself in the ground. Our only purpose in mentioning this circumstance is to call attention to this new missile, if it is actually in use. After removing fragments of the sternum from the wound of exit, the wounds in his chest were closed by the Confederate surgeon into whose care he fell, by rolling up pledgets of lint and pushing them into the orifices—the pledgets being removed every hour or two. He observed that when the lint was removed he breathed with great difficulty, and that he experienced immediate relief when the pledgets were replaced.

This man has now, after the lapse of nine months, a copious purulent discharge from both orifices, and the walls

of the thorax upon that side have already contracted considerably. The posterior portion of the right lung admits air freely, nearly to its base. In front no auscultatory sounds are detected. When he stands erect the right shoulder falls considerably. Most of the time he has a troublesome diarrhœa, yet he is gradually gaining in strength and health, under the management of Dr. Stephen Smith, one of the surgeons attached to the Central Park General Hospital. Brownlee is now taking four quarts of milk, one pint of port wine, and two beef steaks daily.

Case XI.—*Perforating wound of both sides of the Chest—Pyothorax—Probable recovery.*—John McIntyre was wounded at Bull Run, July 21, 1861, by a round ball, which entered the left shoulder, and without emerging from beneath the skin, penetrated the chest, and was found on the right side of the spine, under the skin of the neck. We removed it from this point by a counter-incision, and having dressed it with lint and cool water, he subsequently found his way to Alexandria and Washington. His breathing was difficult at first, but never very greatly embarrassed; and on the 29th of July we found him at the hospital in Georgetown, with somewhat improved respiration, but the wounds were open and discharging, and his expectoration continued bloody. It is not probable that the ball opened fairly into more than one pleural cavity.

Case XII.—*Gunshot wound of the Thorax resulting in pyothorax and death, after ten months.*—Lieut. Mulligan, a gallant young officer of the 21st N.Y.V., was wounded at Manassas, in August, 1862, the ball entering the thorax, over the middle of the clavicle, and emerging near the lower angle of the scapula upon the same side. In its course the ball fractured the first and fifth ribs, and the lower angle of the scapula. This brave boy lay upon the

field seven days without receiving any surgical aid. He says he never expectorated blood, yet there can be no doubt, from the direction which the ball took, that the lungs were perforated. Pyothorax ensued, accompanied with a chronic diarrhœa, and after ten months of suffering he died. By request of his attending surgeon, Dr. J. R. Lothrop, of Buffalo, we saw young Mulligan in March, 1863, seven months after the receipt of the injury, and found him greatly emaciated, the pus discharging freely from the lower orifice, the upper orifice having been closed for some time.

Upon examination after death the lung was found collapsed, and firmly bound by adhesions to the *anterior* surface of the thoracic walls. The pleural cavity was empty, the matter having drained off freely when he was lying upon his back; most of the pleural surface was of a dark color; it contained no foreign matter except a few necrosed fragments of the first rib, which were projecting inwards, near the wound of entrance, and similar necrosed fragments from the fifth rib were found near the wound of exit. Portions of the intestinal tube were much contracted and thickened, as is usual after chronic diarrhœa; the liver was greatly enlarged, and its structure changed by fatty degeneration.

Although it would be improper to attribute the long persistent purulent secretion in this case entirely to the presence of the necrosed bone, yet it is apparent that these fragments were sources of irritation, and the history of the case cannot but impress upon us the importance of removing, by early and free incisions as far as possible, all the pieces of broken ribs, and especially at the point of entrance. When the patient was seen by us the upper orifice had closed, and the ribs had apparently united, so

that we had no reason then to suspect the existence of necrosed bone in that vicinity. At this point it was, however, that the fragments were sent in, and were therefore most capable of doing harm. At the point of exit the necrosed fragments were very little displaced, and if they had been more, they could only have been thrown outwards, in which direction they would do much less mischief.

CASE XIII.—*Post-mortem examination of a soldier who was shot with a large-sized pistol ball through both sides of the chest and heart.*—Edward Barrett, a private in the 32d New York Infantry, was shot by a sentinel on the 30th of January, 1862, through both sides of his chest and through the heart, death occurring in a few seconds. The missile was a musket ball. Assisted by Surgeons Little, Brown, Totten, and others, we made an autopsy on the same day.

The ball had entered on the left side of his chest, about four inches below the inferior angle of the scapula, striking and breaking the lower margin of the eighth rib, and carrying some small fragments into the track of the wound. The wound of entrance was rather smaller than an ordinary musket-ball, oval, its edges slightly inverted and surrounded with a reddened areola, caused by the integument being slightly abraded or deprived of its cuticle by the pressure of the ball before it penetrated the tissues. From this point the track of the ball passed through the free margin of the upper lobe of the left lung, making a contused, but not lacerated, cylindrical channel, which channel was surrounded, through its whole length, by an ecchymosis of about one inch in diameter. The ball then penetrated both ventricles and the right auricle, and through the upper lobe of the right lung, escaping in the right axilla. The track through the right lung presented the same appearance as that through the left; and the wound

of exit was larger by one-half than the wound of entrance, somewhat oval also, the edges not everted, but looking discolored, as if they were blackened by powder. This discoloration was found to be due to a slight extravasation of blood into the tissues under the skin.

The heart was firmly contracted, and contained no blood in any of its cavities; but the pericardium contained about eight ounces, and the two pleural cavities much more. The lungs were completely collapsed. The wounds in the several cavities of the heart were not in any instance more than three lines in diameter, and appeared like slits, as if made by a pointed instrument; but there was no laceration of the structure of the heart, such as we found in the case of Johnson, the deserter, whose heart was penetrated by conical balls. The contraction of this organ will explain, also, in a great measure, the small size of the wounds.

After this man was shot, he uttered one exclamation, and fell apparently dead.

Case XIV.—*Round ball penetrating the chest, and not removed—Fragments of a broken rib probably carried in—Pyothorax—Result probably fatal.*—Malachiah Holmes, colored servant, was wounded at Bull Run, July 21, 1861, by a round ball, which entered his back, breaking his seventh rib and penetrating his chest. He spat blood immediately. Fourteen days later we found him with the wound open, and discharging a coffee-colored and highly offensive serum. On the twenty-fourth day he was sent to his family, in a very feeble condition, with but little prospect of recovery. The ball was never found.

Case XV.—*Pistol ball remaining in cavity of chest—Pyothorax.*—William Patterson, 84th New York Cavalry, wounded Oct. 11, 1863, at Brandy Station, Va., by a pistol shot. The ball entered on the right side, near the sternum,

between the third and fourth ribs, and has never been found. He spat a little blood the following day, and continued to do so moderately for seven or eight days. Air escaped from the wound, also, and some blood. The shock of the injury caused him to faint and to fall from his horse soon after the wound was received.

Five months after the injury we found the wound still open and discharging. The right side of his chest was a little contracted and the lung completely collapsed. He had a troublesome cough, with copious expectoration of pus. He was pale and feeble; but all his symptoms became aggravated when the external wound was closed for a few days. He complained particularly of pain in the back, near the upper margin of the eleventh rib; and this circumstance, together with the fact that dulness on percussion extended over all the lower half of this side of the chest, led us to suspect that the ball lay in the posterior inferior angle of the pleural cavity, near the spot indicated by the pain.

CHAPTER XIII.

PUNCTURED AND INCISED WOUNDS OF THE THORAX.

THERE are certain points of difference between gunshot, punctured, and incised wounds of the chest, which are of sufficient importance to demand a special consideration.

Punctured and incised wounds are made by weapons which are pointed, or which have cutting edges—such as bayonets, swords, dirks, pocket-knives, etc., by which the tissues are penetrated and separated with the least possible amount of contusion or laceration.

The lips of these wounds are not in general widely separated.

They are seldom accompanied with broken ribs. The internal tissues are neither contused nor lacerated.

Only in very few examples are foreign bodies left in the track of the wound.

It follows that punctured and incised wounds often close in their whole extent without suppuration. And in order to insure this result, we do not hesitate now to close the external wounds at once and hermetically; instructing the patient, moreover, to lie as much as possible upon the wounded side, in order to favor adhesion of the pleura-costalis to the pleura-pulmonalis.

It is to these cases especially that the practice recommended by Surgeon Howard, of closing the wound hermetically, by the aid of sutures and collodion, etc., is eminently applicable. If the wound is closed simply by

adhesive plaster, the constant motion of the chest is apt to make it open again, and thus to defeat the object we have in view.

If, notwithstanding all our care, inflammation of the pleura takes place, and serum, with lymph or pus, becomes effused into the cavity of the chest, an opening should be made early with a trocar and canula, to which a pump, furnished with a valve, may be attached, after the plan suggested and practised by Dr. Bowditch, of Boston, Mass.; and if, having made this exploratory operation, the cavity is found to contain only serum and lymph, the wound should, as soon as the fluid is evacuated, be again closed hermetically; the same operation to be repeated at some other point, from time to time, as it may become necessary. If, however, the fluid contained in the cavity is found to be pus, then we think that a free opening ought at once to be made with the knife, and in the most depending point, so that the matter may be allowed to escape without obstruction, and without any reference whatever to the admission of air. We will suggest, also, as the most certain method of securing an outlet at the most depending point, that a strong and long probe, attached to a firm handle, should be bent and carried to the bottom of the pleural cavity, and then pressed outwards between the ribs, to serve as a guide to the incision. A long, flexible, metallic catheter might answer the same purpose as a probe, or in some cases even a solid steel instrument, such as a sound. Something like this method has already been suggested and practised by other surgeons.

EXAMPLES OF PUNCTURED WOUNDS OF THE THORAX.

Case I.—*Superficial punctured wound of the chest.*—Owen McGuire, of Brooklyn, was received into the Long Island

College Hospital, while the author was surgeon-in-chief to that institution, having been wounded with a bowie-knife in the right side of the chest. He had received two wounds, both of which were superficial, the knife having struck upon the ribs and glanced, so that, although the wounds were four or five inches in depth, they did not penetrate the cavity of the chest. He was a good deal alarmed at first, and experienced some embarrassment in respiration, in consequence of the injury inflicted upon the muscles of respiration. The wounds were carefully closed by adhesive plaster, but union by adhesion did not occur, owing, probably, to the constant motion of the ribs in respiration. His recovery, however, was rapid and complete.

The following example of superficial punctured wound is remarkable for being accompanied with excessive dyspnœa, without the presence of air or effusion of any kind into the pleural cavity.

Case II.—A woman was stabbed in a broil on the 5th of June, 1835. The wounds were inflicted by a single blade of a pair of long bank-note shears. She received two wounds in her left arm while warding off the blows, and one upon the side of the thorax, this latter wound commencing near the inferior angle of the scapula, and terminating about five inches from its point of entrance.

We saw the patient within one hour after the receipt of the injury, and upon examination with a long probe found that the weapon had not entered the cavity of the chest. She was pale, alarmed, and her breathing was a good deal embarrassed. A bandage was applied to the chest. In about five hours we were called to see her again, and found the dyspnœa greatly increased; indeed it seemed to threaten absolute suffocation. At the same time we noticed

also a slight trismus. She was ordered to be bled from the arm, and opium was administered. In the morning her breathing was somewhat relieved, but moderate trismus still continued. From this day her symptoms steadily improved, and by the seventh day the wounds had closed by first intention, and she declared that she could breathe as well as ever. She never experienced any further trouble from the wounds.

The trismus and consequent dyspnœa were due in a great measure, probably, to an injury of the median nerve in the left arm; but the dyspnœa was no doubt in part also due to the direct injury inflicted upon the muscles of the chest by the weapon.

In the following case the weapon probably only entered the pleural cavity. If the lung was wounded at all, it could have been only slightly. The orifice was not closed; the wound discharged serum for some time, but recovery took place without the formation of pus.

Case III.—On the 7th of Sept., 1852, Kennada, a watchman, was stabbed with a dirk-knife between the ninth and tenth ribs, on the left side of the thorax. Experiencing at first very little inconvenience from the wound, he did not apply for surgical aid until the third day after. We then found that the wound had not been dressed. No blood had ever been expectorated. Serum was discharging pretty freely from the open orifice. The probe entered the pleural cavity. He had some pain in this side, and complained of a troublesome cough; his breathing was a little embarrassed. Percussion showed dulness over the depending portions of the pleural cavity, which was probably due to an effusion of serum. The wound was permitted to remain open, and the patient was confined to a rigid diet and absolute rest. Three months later the wound had healed,

and no signs of thoracic lesions remained. No pus had ever been formed in the pleural cavity.

In the following case the wound was left open also, and both serum and pus were formed in the pleural cavity :—

Case IV.—Joseph Cook was stabbed with a butcher's knife Sept 2, 1853. The knife entered about four inches from the spine, on the right side, between the ninth and tenth ribs. The surgeon who saw it first very improperly probed the wound freely, his probe entering three inches and a half. There was considerable external hæmorrhage, and a severe pain over the right side for six or eight hours. He did not expectorate blood. It is probable that the knife penetrated the lung, but this is not certain. No means were taken to close the wound, which constituted the second error in the treatment of the case. On the following morning he began to cough, and in a few days the discharge of serum commenced, followed soon by pus. At the end of four weeks the wound had closed spontaneously. In about four weeks more the matter pointed near the old cicatrix, and was again discharged. About three months after the receipt of the injury we found the wound closed, it having remained open this last time only three or four days. No respiratory murmur could be heard over the lower portion of the right side; there was dulness on percussion, and the right hypochondriac region was prominent. No doubt the pleural cavity still contained pus. We advised that the wound should be opened again, but the patient declined to have it done. We have never heard from him since.

In the next case which we shall relate, the weapon penetrated the lung, and air was doubtless admitted into the cavity of the pleura, but the wound being immediately closed, no suppuration followed, and a complete recovery took place.

Case V.—A young man was stabbed with a butcher's knife in the right side of his chest, the weapon entering a little below the nipple. He immediately spat blood freely, and there was considerable hæmorrhage from the external wound. We saw this man within an hour after the receipt of the injury, and found him breathing with great difficulty. We closed the wound with adhesive plaster, and, as he was in full health, we bled him freely from the arm. A bandage was placed about his chest, and he was instructed to lie upon the wounded side. This instruction, however, he found it difficult to obey, since he was only able to breathe with tolerable comfort when he was sitting up. Opiates were administered from time to time for several days, and the bleeding was once repeated. A severe cough, with the usual signs of pleuro-pneumonia, followed, but from these he gradually recovered, without there having been any considerable effusion of fluid of any kind into the pleural cavity. The wound closed by adhesion, and remained closed. His convalescence was rapid and complete.

This case occurred in the first year of our practice, and as the man who had received the injury was a notorious villain, there was a very general desire openly expressed on the part of many citizens that his wounds should prove fatal; and the nature of the injury seemed to encourage a reasonable hope that such a result would ensue. So far, therefore, from receiving credit for our success in this case, we were not a little chagrined and disappointed to find that our popularity was seriously impaired by the fact that we had lent our art and services to so bad a purpose.

Punctured wounds of the heart are, like gunshot wounds of this organ, in most cases quickly fatal; but death as the result of these injuries is not generally quite so immediate,

and a few examples are recorded of final and complete recovery. Admiral Villeneuve committed suicide by thrusting a long pin into his heart, and his death is said to have taken place almost immediately. Upon examination after death the surgeons could scarcely discover a trace of the wound. On the other hand, it is well known that needles have been introduced into the hearts of animals by experimenters, and a current of galvanic electricity sent through them without doing any harm. Dr. Babington relates a case in which the patient survived a bayonet wound of the heart twenty-four hours. Dr. Featherstone reports an example of the same kind, in which death occurred after forty-eight hours. Mr. Guthrie examined the body of a man who had been wounded by a lance at the battle of Waterloo, and who died in consequence of an attack of pneumonia, in November, 1815. The lance had penetrated the left lung, the pericardium, the heart, the diaphragm, and the liver, all of which wounds had completely cicatrized. The wound in the heart was indicated by a sort of flap which hung down from the outer wall of the right ventricle, showing that the weapon had not penetrated the entire thickness of the wall, but merely sliced off a small portion. Breschet mentions an example of laceration of the pericardium and slight wound of the heart, in which the patient survived twelve days. Dupuytren and Begin have each reported one example of complete recovery after punctured wounds of the heart.

In Dr. Purple's paper on "Wounds of the Heart," to which reference has already been made, he has collected thirty examples of punctured wounds. Two of these survived twenty-five days; in one of which—the case reported by Dr. Richards—the wound was inflicted by a penknife. The pericardium had been penetrated and the anterior coro-

nary artery was divided.* In the other example, reported by Dupuytren, the heart had been penetrated at six different places by a saddler's needle.

* Boston Med. and Surg. Journal, vol. xxxv. p. 336.

CHAPTER XIV.

GUNSHOT WOUNDS OF ABDOMEN.

In our study of gunshot injuries of the abdomen, we shall find it convenient to adopt the same division of the subject as in similar injuries of the chest. We shall accordingly speak of them as superficial, perforating, and penetrating. A superficial wound or injury of the abdomen is one in which the parietes alone are implicated. A perforating wound is one in which the missile has traversed the cavity of the abdomen, having escaped from the opposite side by its own momentum, or having been removed from underneath the skin by the surgeon. A penetrating gunshot wound is one in which the missile, having fairly entered the abdominal parietes, has not retained sufficient force to pass through, and remains in the body.

Section I.—Superficial Gunshot Injuries of the Abdomen. In consequence of a severe blow upon the walls of the abdomen, inflicted by a solid shot, some portion of the muscular or tendinous parietes may suffer laceration; and this has happened sometimes when the integument was not broken. The injury to the muscle or to its tendon may be sufficient to cause an immediate hernial protrusion, under which circumstances the hernia, in most cases, becomes at once strangulated, causing great pain, accompanied with nausea and vomiting, and demanding prompt surgical interference.

In other cases, as a result of the contusion, the muscular tissue suffers a gradual atrophy, and the portions of tissue which remain undergo a degeneration, in consequence of which they become weakened, losing their power of contraction, and even of passive resistance, so that they finally give way to the pressure of the contained viscera. In this manner we see developed slowly in some cases what may be properly called large hernial protrusions, but in which it must be understood there is no absolute lesion of structure. We see the same atrophy, degeneration, and partial paralysis occasionally in other muscles of the body from similar causes, and especially have we had occasion to notice its occurrence after contusions of the deltoid muscle.

The immediate cause of this atrophy seems to be the inflammation produced by the injury, and to this may be added the long-continued disuse of the muscle. Muscular fibre is rapidly developed by action, and becomes as rapidly atrophied when inactive. And it is certain that to desuetude, absolute and long-continued, we must in many of these cases ascribe, in a great measure, the subsequent wasting and degeneration.

With a view to the prevention of such a result, the patient ought at first to be laid upon his bed and kept perfectly quiet, and such other measures should be taken as may be necessary to prevent or subdue inflammation; but as soon as the inflammation is fairly overcome, a broad and well adjusted bandage should be placed around the abdomen, and the patient should be allowed to take such moderate exercise as may be best calculated to bring these muscles gently into action. Frictions daily employed, and even blisters, may prove serviceable.

If, however, the muscular paralysis continues, nothing can be done but to support the weakened walls of the abdo-

men by a broad and well-padded bandage, or by properly constructed trusses.

We have met with one example of ventral hernia from atrophy and degeneration of the muscular parietes in civil practice, in the person of a woman aged thirty, who was admitted into the Buffalo Hospital on the 17th October, 1850, suffering with cancer of the womb. This woman had given birth to two children, but the last of them was born four years before the hernia commenced. The cancer had been progressing about one year; there was no such enlargement, however, as to cause any increased pressure upon the walls of the abdomen. A few months before her admission she fell against the corner of a table, striking upon the front of her abdomen. Some slight tenderness followed, and soon the protrusion commenced. When admitted, the whole of the muscular portions of the two recti abdominis seemed to be completely absorbed, so that when she made an effort to contract the muscles of the abdomen, a hernial protrusion occurred of the exact length and breadth of the recti muscles, extending from the ensiform cartilage to the pubes. This had taken place gradually and within a period of four months.

Occasionally round balls have been found to penetrate beneath the integuments of the abdomen, and, being turned aside by the aponeurotic expansions of the muscular fibres, they have made a considerable circuit. We have not seen this happen to any considerable extent with the conical ball, and it is probable that it seldom occurs. Indeed it would be an error to suppose that even the round ball is very often thus deflected. In general it may be assumed that the direction taken by the missile corresponds to a nearly straight line drawn between the points of entrance and exit. If the missile has not passed entirely through,

the probability of such a deviation is much greater than when the perforation is complete.

We have recently seen a case in which a pistol ball, fired at a very short range, but a little obliquely, was deflected by the muscular aponeurosis of the front of the abdomen, and passed along four or five inches immediately under the skin, until it was again deflected inwards in a manner which was not easily explained, burying itself deep in the pelvic cavity.

In some of these cases, and especially when the course of the ball is entirely subcutaneous, its track is indicated by a slight discoloration, like that which marks the course of inflamed and superficial absorbents. Usually this discoloration is not present until after the lapse of a day or two, and then it may be attended with a moderate degree of induration and swelling, so that it feels like a cord, and is tender upon pressure.

There is present, also, in a few cases of long subcutaneous wounds made by conical balls, canister, and other large shot, a sensation of crepitus under the finger, like the rustling of leaves, and which, if present immediately after the occurrence of the accident, as we have sometimes found it to be, must be due to the admission of air which has followed the track of the missile. At a later period a similar sensation may be occasioned by the presence of lymph among the broken and disorganized tissues.

In all these superficial injuries, that portion of the peritoneum which lines the walls of the abomen is liable to become inflamed, partly from the direct injury which it has sustained by the concussion, and partly from an extension of that irritation which is primarily developed in the track of the wound. Flesh wounds of the back are much less liable to give rise to peritonitis, owing to the greater thick-

ness of the muscles in this region, and to the absence of the reflected peritoneum along those portions of the loins upon which the abdominal viscera have their principal attachments.

We were permitted to see, at Frederick City, Md., under the care of Surgeon Lewis, U.S.V., a soldier belonging to the 2d U.S. Sharpshooters, who was wounded at Antietam, on the 17th of September, 1862, by a conical ball which entered just above the right ilium, a little to the outside of the right sacro-iliac junction, and, having passed across the muscles of the back, had emerged upon the left side, from which position it was removed by Surgeon Lewis on the 23d day. Neither the vertebræ nor any of their processes seemed to be injured, and it is probable that the ball passed between two adjacent spinous processes. We have before remarked that balls which, deflected by subcutaneous structures, make the circuit of the body, are usually arrested or thrown to the surface when they reach the spinous processes; in this example it will be noticed that the course of the ball was direct, and it does not therefore constitute an exception to my remark; but in alluding to this case our particular object was to mention that no symptoms ensued which would indicate that inflammation had reached the peritoneum.

The effects of the concussion often reach far beyond the parts upon which the missile immediately touches, even when the walls themselves suffer no apparent lesion. A large shot, whose momentum is nearly expended, may cause instant death as it falls, or obliquely impinges upon, or rolls over the surface of the belly. We have already mentioned, in our general remarks, an example of this kind which came under our observation. In such cases death is the result of the shock, and it is not necessarily accompanied with any lesion of the viscera.

In other cases the viscera are ruptured, and especially is it not uncommon to find a rupture of the liver or spleen; occasionally the kidneys are torn; and still more rarely the stomach, bladder, and other hollow viscera.

In case neither the wound nor the shock extends beyond the muscular parietes, the constitutional symptoms are usually very mild. If the patient, under these circumstances, looks pale and becomes faint, or is affected with nausea, these phenomena must be in most cases ascribed to alarm rather than to the injury itself. It is true, however, that these symptoms are more or less present in a great majority of cases; and since the anterior and lateral muscular walls are in such close connexion with the peritoneum, it is not improbable that this delicate and highly vitalized membrane feels the shock, and reflects its injuries upon the great nervous centres, in many instances of really superficial and slight wounds.

On the 11th of July, 1854, a lad sixteen years old was shot accidentally by his comrade, while out shooting pigeons. The weapon used was a musket loaded with small shot, and the distance was about thirty paces. About one dozen shot entered various parts of his body, only one of which took effect upon the abdomen. This one entered four inches above the anterior superior spinous process of the right ilium, causing a severe pain in that region, accompanied with faintness, and being followed by a diffused tenderness, but no strongly marked signs of peritonitis. We were unable to find any of the shots. In a few weeks he was entirely well.

We have known complete but temporary paralysis of the bladder occasioned by the mere concussion of small shot, as in the following example:—

William Graham, a private in the 12th N.Y. Inf., at the

battle of Blackburn's Ford, on the 18th of July, 1861, received a charge of buckshot just above the pubes, upon the abdomen. We saw this man on the same day, and also on the third day following the injury. Surgeon Palmer (Prof. Palmer, of Ann Arbor, Mich.) extracted all of the shot very soon after the wound was received, none of them having penetrated deeply; but he was found to have paralysis of the bladder. On introducing the catheter the urine was observed not to be bloody. There was no evidence, therefore, that the bladder had suffered any lesion. There was no paralysis in any other portion of his body. The bladder resumed its functions completely after a few days.

It is probable in this case that the paralysis of the bladder was due alone to the shock or concussion upon the parietes of the abdomen.

The signs which indicate a rupture of the internal viscera can scarcely be mistaken for those which sometimes accompany these slighter injuries. When the liver or spleen has suffered lesion the patient in most cases dies speedily from internal hæmorrhage, rarely surviving twenty-four hours; in other cases the hæmorrhage is more gradual; but in all such examples there are added to the usual signs of nervous shock the signs of progressive and excessive exhaustion consequent upon the bleeding.

Only a few days ago a man was brought into the wards of the Long Island College Hospital whose body had been traversed by a carriage wheel, the accident having occurred about twenty minutes before his reception. The symptoms plainly indicated a rapid internal hæmorrhage. He was pale and bathed in a copious, clammy perspiration. No pulse could be felt at the wrist, and his abdomen was already very tumid. He died in an hour and a half from the time of the receipt of the injury. On examination

after death we found an extensive laceration on the convex surface of the liver, commencing about two inches below the right lateral ligament, and extending upwards and inwards to the posterior extremity of the spigelian lobe. No other viscera or vessels had suffered laceration. The cavity of the abdomen was completely filled with dark venous blood.

On the 1st of July, 1860, a boy eighteen years old was admitted into this same hospital, who had just been struck by a whiffle-tree on the right side. He was pale and exhausted. His pulse was small, soft, and slow, and he was continually retching and vomiting. On the following morning we found his belly swollen and tender, and he was unable to evacuate his bladder. The symptoms led to a suspicion of a rupture of the liver, but as the prostration was not greatly increased, and as peritonitis was developed in some degree, the suspicion was not fully confirmed. His urine was withdrawn by a catheter, and warm fomentations were applied to the belly, while opium was administered internally.

His death occurred at the end of about forty-eight hours from the time of the receipt of the injury, and the autopsy disclosed the fact that the margin of the liver on the right side was torn vertically to the extent of four inches, and the cavity of the peritoneum was filled with dark-colored blood; there were also some recent deposits of lymph upon the surface of the peritoneum.

In regard to the local treatment of superficial gunshot wounds of the abdomen very little needs to be said. If we can be certain that the missile has not penetrated the cavity, it will be better to leave them open, only covering the orifice of the wound with a simple ointment spread upon lint or a piece of cloth. Water, when employed in

these cases, as in all other injuries of the abdomen, should be tepid or warm. Abundant experience has shown that peritoneal and intestinal inflammations cannot be treated so successfully by cold external applications as by warm. Indeed, when we allow ourselves to be governed by that rule which we have already laid down in our general remarks on the treatment of gunshot injuries, namely, that we should employ that temperature which is most agreeable to the patient, we shall not resort to anything but warm fomentations in the cases now under consideration. Invariably, so far as our experience extends, patients have declared themselves comforted by warm fomentations, and annoyed, chilled, or distressed by the cold.

Absolute rest should be enjoined in the recumbent posture, and, as far as possible, the posture should be that which will most completely relax the abdominal muscles and favor the coaptation of the wounded surfaces.

Cathartics are generally forbidden, but it is desirable that the bowels should move occasionally, if it can be accomplished without much disturbance of the patient and without the agency of active medicines. The diet must be low. If peritonitis is threatened, opium, the lancet, and leeches may be demanded.

Another result of these superficial gunshot injuries may be the formation of an abscess between some of the various tissues composing the abdominal walls. Most commonly these abscesses form outside of the muscular and tendinous expansions, and in such cases they are attended with but little danger. But whenever matter is deposited more deeply it finds its way with difficulty to the surface, and it may after a time open into the cavity of the peritoneum, or, what is more likely to happen, it may fall down towards the pubes, and then disperse itself in the loose cellular tis-

sue of the pelvic cavity. Either of these events is very apt to prove fatal, and ought to be prevented, if possible, by an early diagnosis and a timely operation. It is sometimes exceedingly difficult to determine the existence of matter at this point, owing to the little resistance given by the subjacent parts, but in a case of doubt the surgeon may generally complete his diagnosis by the use of the exploring needle. If pus is found, no time should be lost in giving it a free exit. At the same time the surgeon must be warned not to make any unnecessary incisions of the muscular or tendinous coverings of the abdomen, especially where the walls are naturally thin, as upon the sides and front, since such incisions are almost inevitably followed by hernial protrusions after the wound has cicatrized.

SECTION II.—PERFORATING GUNSHOT INJURIES OF THE ABDOMEN. Of these there are two classes, namely, those in which all of the important viscera have escaped a rupture or other serious lesion, and those in which more or less of the viscera have been wounded.

Let us consider, first, *those in which all the important viscera have escaped a rupture or other serious lesion.*

In the vast majority of cases, no matter what missile has been employed, if it has actually passed through the abdominal cavity, some of the visceral contents of this cavity have suffered absolute lesion. The most frequent exceptions are found in the case of the smooth, round ball, and of smaller shot. The conical ball and the larger shot rarely turn aside themselves, or permit any of the viscera to move out of their way, in their course through the abdomen. But even these projectiles furnish a certain number of rare and almost unaccountable exceptions.

Much will depend upon the region through which the

ball has penetrated, in estimating the chances that the viscera may have escaped. Thus it will be found that lesions of these organs occur most frequently in either of the hypochondriac regions; and these wounds furnish the largest number of fatal results. In the remaining regions the serious internal lesions and the fatality of the wounds may be arranged upon a descending scale in nearly the following order:—Epigastric region, umbilical, right and left lumbar, hypogastric, right and left inguinal. Indeed so frequently do the viscera escape injury when the ball has passed through the inguinal regions, we cannot but conclude that, in very many of the examples, the missile has made its *trajet* below and outside of the reflections of the peritoneum.

Our notes furnish us with six of these fortunate cases, six of which occurred in the inguinal region, and in all of these latter, save one, the bones of the pelvis were penetrated; one occurred in the lower part of the left lumbar region, and the bones of the pelvis were not injured. The cases are as follows:—

Case I.—Clement Grant, a private in the 22d N. Y. Vols., Inf., was wounded Sept. 17th, 1862, at Antietam, by a ball which entered the right groin, above Poupart's ligament, between the external and internal inguinal rings, and escaped on the nates, a little to the outside of the right tuber ischii. He walked one mile after being wounded. About three weeks after the receipt of the injury we saw this man at Frederick City, Md. The wound upon his nates was then discharging pus quite freely, and he only complained of occasional pains in the right thigh. It is probable that some of the pelvic bones were broken, but no fragments had escaped. None of the viscera of his abdo-

men had suffered injury, and there was no tenderness over the abdomen, except near the anterior wound.

Case II.—George Knoll, of the 7th Va. Vols., was wounded at Williamsburg, Va., in May, 1862. A ball entered just back of the left trochanter major, and passing forwards and towards the centre of the body, made its escape in front near the situation of the internal abdominal ring. The wounds were treated with cool water dressings. He was only confined to his bed five days, and in a short time he returned to his regiment perfectly sound. We saw him after the battle of Antietam, lying in the hospital under treatment for a wound of the thigh which he had just received.

Case III.—Jasper Haynes, private, 157th N. Y. Vols., 11th corps, wounded at Gettysburg, first day (July 1, 1863), by a conical ball, which entered just above the anterior superior spinous process of the ilium, on the left side, and escaped on the back, passing through the left side of the pelvis, near the sacrum. He immediately fell to the ground, and felt numb over his whole body and faint. The wound bled very freely, but he soon arrested the bleeding by a silk handkerchief made into a wad and secured by a towel tied about the body. He lay upon the field twenty-four hours. No treatment was subsequently adopted, except the application of a piece of adhesive plaster and cool water dressings over the whole side of the abdomen. Peritonitis was developed within a short time, and then warm flaxseed poultices were substituted for the cold water dressings. A number of fragments of bone have escaped, and other fragments can still be discovered in the wound. Suppuration continues after the lapse of nine months. Fæces have never escaped through either wound.

The fragments of bone in this case have, no doubt, per

petuated the suppuration; and, as they came alone from the pelvis, near the point of exit of the ball, and must have lain between the bone and the integument, they ought to have been removed at the first dressing, by the surgeon.

Case IV.—A Confederate soldier of the 51st Ga. was wounded at Antietam by a conical ball weighing one ounce. The ball entered back of the right trochanter and passed out through the left side of the abdomen in front, about opposite the internal abdominal ring. The patient found the ball projecting partly through the skin, and pulled it out himself. Twenty-three days after, we found him free from fever and with but very little inflammation, the wounds discharging moderately. No fæcal matter or urine had ever escaped by the wounds. He had been treated by rest and cool water dressings alone.

Case V.—While we were stationed at Yorktown, Va., on the staff of that gallant and vigilant officer, Major-General Keyes, the enemy made frequent attempts to surprise and drive in our outposts. On one of these occasions, the 9th of September, 1862, a force of rebel cavalry fell suddenly upon the camp of the 5th Pa. cavalry, stationed near Williamsburg. Among the wounded who were brought in and placed under our care was private Jacob Walter, who had received a round ball, perhaps a large pistol ball, through the right wing of his pelvis; after penetrating the bone it passed forward about four inches, and made its escape just in front of the anterior superior spinous process of the ilium. The hole through the bone was round and smooth, admitting easily the forefinger of the right hand; and it was evident, from its course through the integument, muscle, and bone, as compared with its course after it had entered the cavity of the belly, that its direc-

tion had in some way been changed, the deflection from its original course being, at the point of exit, at least fifteen degrees.

The viscera of the abdomen were not wounded; the shock from the injury was very slight; and when we last saw this man, a few days later, the wounds were doing well.

Case VI.—On the same occasion we dressed the wounds of E. A. Hass, a private in the same regiment, who was shot through the lumbar region, on the left side, just above the top of the pelvis, the wounds of entrance and of exit being about seven inches apart. In this case also the intestines were uninjured and the wounds closed rapidly.

In the following case the ball passed through the cavity of the pelvis below the peritoneum, wounding the rectum. N. W. H. was wounded on the 6th of May, 1864, in the "Wilderness," by a rifle ball which entered the left thigh, two inches below the top of the trochanter major, passing in front of the femur and emerging on the right side about the same distance below the top of the trochanter major and behind the femur, making only two external wounds. The ball had traversed the rectum just above the sphincter ani. For several days fæces passed by both wounds in his thigh, but on the tenth day it had ceased entirely, and he was doing well.

Since writing the above we have seen three more examples from the battles of the "Wilderness," in which rifle balls have entered the upper part of the thigh, penetrating the viscera of the pelvis, and which wounds for a few days gave exit to fæces, but are now closing up rapidly.

There are many cases in which we are not able to declare at once, in the first examination, whether the viscera have been ruptured or not. It will seldom, if ever, be proper to introduce a probe or to lay open the wound for the sole

purpose of deciding this point. If blood passes by the stomach or bowels, or if the contents of the hollow viscera escape externally, the diagnosis is clear; the presence or absence of tympanitis is also a sign of great importance, and in some cases the internal effusions can be plainly made out. Very much may be inferred, moreover, from the severity of the symptoms and from their persistence or steady increase in gravity; but it is possible that very grave symptoms may ensue, and even death may result speedily, when there has been no such lesion. It will be impossible, therefore, in some instances, to make out the diagnosis fully until the results have been obtained, and even then it is often a negative rather than any positive testimony upon which we must rely.

If, then, no blood is thrown from the stomach or is passed by the bowels; if the faintness, nausea, and prostration are only moderate; if the patient suffers but little pain, and there is no tympanitis; if the consequent peritoneal inflammation is not great, and percussion gives no indication of effusion; finally, if after the lapse of several days none of the contents of the viscera are found to escape through the wounds and the general symptoms continue to improve, it will be fair to assume that no important internal organs inclosed by the peritoneum have suffered serious lesion. And to this conclusion we shall arrive with additional assurance if the wound is situated in the inguinal region or in the lower part of the lumbar.

The treatment of these injuries ought always, at least so long as a doubt remains in relation to the exact diagnosis, to be based upon the same principles which are to govern the treatment of gunshot wounds penetrating the viscera. After having made such an examination of the wound of entrance as may be necessary and proper, to determine

whether any foreign substance has entered and been left in the track near the point, both orifices should be immediately closed. The patient should be laid in bed in such a position as to secure rest and relaxation of the muscles; the stomach should be kept empty and the bowels quiet with opium; warm fomentations should be applied, and such antiphlogistic remedies employed as the circumstances may indicate. In no case ought the probe or the fingers to be introduced beyond or through the walls of the abdomen in search of foreign substances or for the purpose of determining the nature and extent of the injury. Upon all these points we shall speak more at length hereafter when treating of those examples in which the viscera have been actually wounded.

In the January number, for 1859, of the *Buffalo Medical Journal*, we have published an account of a case of perforation of the belly by an iron rod, which occurred in the practice of Dr. Throop, Luzerne Co., Pa. The report is substantially as follows:—In February, 1845, a young man, aged about twenty-five, a harness and saddle-maker by trade, got upon a table for the purpose of speaking through a trap-door with a shoemaker who occupied the room above him. The shoemaker, in sport, offered to throw a last at the saddler's head; in dodging to avoid which, the latter lost his balance, falling forwards, and encountering in his descent an iron rod used for filling collars, which was four and a half feet in length, nearly half an inch in breadth at the point, and expanding rapidly to a breadth of five-eighths of an inch, but slightly flattened in the opposite diameter. The surface of the rod was rough, having been only recently forged by a common blacksmith. It entered the abdomen four inches below the umbilicus and two inches to the right of the median line, and came out

upon the back on the same side, two inches from the centre of the spine and about opposite the last dorsal vertebra. He immediately arose and pulled out the rod himself; he then walked across the street and sent for Dr. Throop; Dr. T. examined the wounds, which had bled only a few drops, and closed them with adhesive plaster. The patient was ordered to be kept upon a low diet, and his bowels were to be moved occasionally by an enema.

Dr. A. Knapp, who reported this case to us, saw him on the eighth day after the accident, and found him sitting up in bed amusing himself with his violin. He declared that he had suffered no pain except a slight stinging sensation when he drew out the rod, and that he now felt no inconvenience except from hunger and the consequent exhaustion. Subsequently Dr. Knapp saw him at work at his trade as usual, his recovery being complete.

Guthrie relates a very similar case, a soldier having been completely transfixed by a ramrod. The small end entered about two inches below the umbilicus, and, penetrating the second lumbar vertebra, protruded an inch and a half on the opposite side. It was removed, and his recovery took place in a short time and without a single grave symptom.

Second—*Perforating Gunshot Injuries of the Abdomen, complicated with wounds of the Viscera.*

The small intestines, owing to their extent and to their central, superficial position, are peculiarly exposed to wounds. The duodenum, however, constitutes an exception to this remark. It is not very infrequent also to find the small intestines wounded several times by the same ball.

The small intestines, with the exception of the duodenum, are almost completely invested with peritoneum, so

that all wounds which penetrate their walls completely, open directly into the great peritoneal cavity. Suspended loosely by the mesentery from the posterior wall of the abdomen, they float freely within the limits assigned to them; and when they are wounded, the orifices which have been made in the intestinal tube seldom maintain, for any considerable time, an exact apposition to the orifices in the parietes. This tendency to displacement is very much increased, immediately upon the receipt of an injury, by an increase of the peristaltic motion of the bowels, that is, by the alternate contraction and relaxation of the circular and longitudinal muscular fibres. The retching and vomiting still further promote the displacement of the wounded surfaces.

There is in fact no peritoneal cavity, properly speaking, when the organs are all in their natural position and in health. Those portions of the peritoneum which invest the intestinal tube are in absolute contact either with themselves, or with that portion which lines the walls of the abdomen. If this contact could be maintained, no effusion of the contents of an intestine, or of any of the other viscera of the abdomen, could take place after the occurrence of a wound; but it will be easily understood how, by the admission of air from without through the track of the wound, the peritoneal surfaces may be separated, and a peritoneal cavity may be actually formed into which the contents of the intestine, impelled by peristaltic action, may be now freely poured.

Perhaps this effusion of the contents of the intestine does not always happen in the precise manner which we have here supposed. Another theory of explanation may be adopted which is equally plausible, and which may apply to a greater or less proportion of these cases.

The intestines contain always a certain amount of gas, upon which their elastic and muscular coats are more or less firmly contracted. Immediately upon the receipt of a wound these tissues contract with additional vigor, and the imprisoned air being displaced along the tube, finds a ready exit through the wound in the intestine, but owing to the loss of parallelism between the wound in the intestine and the wound in the walls of the belly, it is driven outwards laterally, the intestine collapses, and the gas is made to occupy the cavity of the peritoneum. The gas having in this manner once gained admission to this cavity, the fluid and even solid contents of the intestine will not find it difficult to follow.

In other cases it is probable that the fæcal matter is displaced and carried forwards by the missile, precisely as any other substance may be which happens to lie in its way.

It is nevertheless important that the surgeon should understand that, in case this effusion has not already occurred, it is most certain to take place, if, in his injudicious zeal to explore the wound, he opens freely to the external air the cavity of the peritoneum. It is not because the air in itself may irritate or inflame the peritoneal surface that we advise its careful exclusion—indeed we are not fully persuaded that it will do any harm in this regard—but because it opens the way for extravasation of the solid and fluid contents of the viscera.

The large intestines, only partially covered by peritoneum and immovable, when wounded do not expose the patient to such imminent hazard of fæcal extravasations, and the results are much less often fatal. Indeed it is upon these portions of the intestinal canal that surgeons have not hesitated to carry their incisions, for the purpose of

establishing, in certain cases, an artificial anus, and the results have fully established the safety and propriety of the procedure.

In view of the statements now made as to certain anatomical relations and peculiarities of these viscera, we are prepared to consider, in case they have been penetrated by a ball, what methods of treatment are most rational, and how far such methods are sustained by experience and observation.

Confining our remarks for the present to those examples in which the ball has completely perforated the abdominal walls and has escaped externally, of course no exploration of the wound is demanded for the purpose of extracting the missile. If, however, the ball has made its entrance through any portion of the bony parietes of the abdomen, it may have carried with it fragments of bone which it would be exceedingly desirable to remove as speedily as possible.

Balls which have penetrated the abdomen through the dorsal region sometimes carry with them, to a certain depth, portions of the dorsal vertebræ, and especially of their transverse and oblique processes, but it is seldom that these fragments are driven fairly into the abdominal cavity. The numerous strong ligamentous and tendinous attachments which cover so completely nearly all the surfaces of both the bodies of the vertebræ and their processes, render their complete detachment very difficult, if not impossible; while the depth of muscular coverings upon their lateral and anterior surfaces still further protects the internal viscera from the projecting points of the displaced spicula. There does not exist, therefore, the same necessity for extracting these fragments as in some other cases which we shall mention.

When the track of the wound is through the body of the vertebræ, in most cases the spinal marrow or its immediate coverings have been seriously injured, and surgical interference would prove worse than useless; or the large bloodvessels lying in front have been lacerated, and death occurs as speedily as if the heart itself had been opened.

In a few cases a round ball has been known to pass through the side of the body of one of the vertebræ, leaving a round hole or a lateral furrow, without coming in contact with either the spinal marrow or the bloodvessels. It is not probable that we shall be able to diagnosticate such a case clearly during the life of a patient; and if we were able to do so, we do not see what benefit could be derived from any surgical operation.

In case, however, one of the transverse processes has been broken and sent inwards, although it is not likely to have penetrated the cavity of the abdomen, it yet may give rise to serious results by the formation of an abscess in the bellies of the psoas muscles, which abscess may eventually make its way along between their fibres towards the groin, or it may empty itself into the loose areolar tissue outside of the peritoneum. These results have occasionally happened, and it is worthy of consideration whether, in such a case, it may not be proper to attempt the removal of the broken process at an early moment. This operation will be rendered the less difficult from the fact that the fragment will probably not be beyond the reach of the forceps, and if it cannot be extracted, it may at least be in some manner replaced, so that its extremity shall no longer press upon and goad the muscular tissues. The danger of the operation will be the less, also, for the reason that the operator is not so likely here to penetrate the cavity of the peritoneum.

If such an operation should be thought justifiable, the incision ought to be made at a right angle with the axis of the body, across the fibres of the lumbar muscles, and directly upon the transverse process, avoiding as much as possible the space between the adjacent processes, in which situation are found the principal muscular branches of the lumbar arteries.

It is much more common to meet with examples of gunshot wounds penetrating the cavity of the abdomen which have entered through the alæ of the pelvis, in which cases the ball seldom fails to carry with it fragments of bone.

In most examples the openings made by smooth round balls, and even by conical balls through the alæ of the pelvis, are simple perforations, and are not accompanied with much comminution or fracture of the bone beyond the margins of the opening; but numerous small fragments displaced at the point of perforation, and a few larger fragments split off from the inner surface of the bone, are usually found driven inwards. This is especially the case when the missile strikes upon the crest of the ilium.

In all these cases, even though the projectile may not have penetrated the viscera, the cure is apt to be delayed by extensive and prolonged suppuration, the numerous small fragments being with difficulty discharged through the wound of entrance, but making their way easily downwards into the loose areolar tissue of the pelvic cavity.

If the ball has penetrated either of the alæ where they are thickly covered by the great gluteal muscles, it would be difficult to discover or to remove the fragments. The great depth of the muscular coverings, and the size and number of bloodvessels with which they are supplied, render all surgical interference improper. But in case the perforation occurs near the upper margin of the pelvic bones, there can

be no impropriety in instituting a search for any foreign substances which may be supposed to have lodged within. If the edge of the crest only is broken off, the finger can be easily and safely carried along the track of the wound to a certain extent, and the probe may be introduced pretty freely without much danger of its doing harm. Indeed it is our opinion that, in case the perforation was very near the crest of the ilium, constituting only a smooth, round hole through which the loose fragments could be distinctly felt, but which was insufficient for their extraction, it would be proper to apply the trephine, so as to enlarge the opening. Certainly there is no more important indication than to remove the fragments, and we do not see why the surgeon, under these circumstances, need hesitate to perform so trivial and safe an operation at once. For this purpose a large trephine should be employed, and in order to avoid the necessity of dissecting up the muscles extensively for the purpose of finding a sound piece of bone upon which to rest the pin of his trephine, he might adopt the excellent suggestion of Mr. Guthrie in certain cases of fracture of the skull—namely, to support the crown of the instrument in a circular opening made in a bar of iron, the two ends of the bar being held and steadied by assistants; or perhaps it would answer equally well to employ for this purpose a piece of wood, the opening in which may have been previously made by the trephine itself.

With the exceptions which we have now stated, to which may possibly be added a few examples in which fragments of ribs have been slightly driven in, it will be improper to make anything but the most superficial exploration of the wound, either with the finger or the probe. In short, it is necessary to declare positively that, whenever the missile has penetrated or perforated fairly the cavity of the abdo-

men, except in certain cases where the ball has penetrated the liver without impinging upon any portion of its bony parietes, all such deep explorations, for whatever purpose instituted, are positively mischievous, or at all events eminently hazardous.

We are not aware that any late surgical writer or teacher, except Legouest, has called in question the soundness of this maxim. This surgeon, in his treatise on Army Surgery, published at Paris so late as 1863, recommends digital explorations for the purpose of ascertaining whether a ball has penetrated an intestine. While he can find no justification for this procedure in the case of a narrow punctured wound, he proceeds to say :—"But if the wound is made by a cutting instrument, or by shot, we think that it is imprudent to place reliance upon the phenomena previously described; that it is necessary to assure ourselves immediately of the absence or of the presence of an effusion; and if the effusion is found to exist, it is proper to interpose by an operation. The finger ought, therefore, to be introduced into the belly and moved about; if it is withdrawn without being soiled with intestinal matter, we may suppose that the perforation of the intestine is closed by the protrusion of the mucous membrane, by the interposition of the epiploon, etc., and we may confine ourselves to the general means of treatment already indicated. We must not forget, however, that during the first moments after the receipt of the wound, the spontaneous contraction of the intestine opposes an obstacle to the escape of both solid and liquid matter, but that the gas may escape and communicate to the finger an odor easily recognised. In such a case we should keep the external wound open, and compress the walls of the belly, in order to favor the escape of the gas from the abdominal cavity. If, on the other hand,

the finger is withdrawn soiled by the matter which has escaped from the digestive tube, we should dilate the external wound by an incision, draw the intestine out, and reunite the solution of continuity by the suture. Plunged into a wound of the abdomen, the finger often encounters the intestinal lesion immediately back of the opening made in the peritoneum, and recognises the ends of the divided intestine by the spasmodic contraction with which they are seized, and which gives to them a hard consistence like cartilage."

The distinguished position which this writer occupies renders it necessary that we should give to these extraordinary statements a careful consideration.

It is unfortunately true that in nine cases out of ten, when a ball has penetrated the abdomen, the patient dies within twenty-four or forty-eight hours; and it is equally true that his death is in a great majority of cases caused by extravasation of the contents of the bowels into the peritoneal cavity, and the consequent inflammation. It is indeed not certain that a conical ball ever traverses the region occupied by the small intestines without causing both a rupture of the tube and an extravasation of its contents to a greater or less extent.

On the other hand, it is known that a certain number recover after such injuries without any conclusive evidence having been furnished that the intestine was wounded; and that a number still larger recover, with either a permanent, or, as more often happens, with only a temporary discharge of fæcal matter through the wound; and these results have happened under what has been termed the "general plan of treatment"—that is, without surgical interference.

It was the first duty, therefore, of M. Legouest in announcing this novel plan of treatment, to show, by a reference to facts, that his method had obtained more for-

tunate results. This he has not done. He has failed to report even one example of cure after a gunshot injury by the use of the intestinal suture. And the records of the intestinal suture, as applied to this class of injuries, have always been found to be nearly equally barren of facts; for it must be understood that the suture has before been employed in cases where a protrusion or a complete exposure of the viscera seemed to render the practice proper. It is only in its application to concealed wounds of the intestinal tube demanding explorations and incisions in order to bring the wounds into view, that the suggestions of this author appear novel, and seem to demand special attention.

We have already explained the causes and the manner of these fæcal extravasations, and we have seen how the opening of the wound and the admission of air, or the disturbing of the viscera by the finger or by any other means, is liable to greatly increase this tendency to extravasation.

In most cases, when the ball has penetrated the small intestines, they are found to have been perforated at several points. In certain experiments, lately made upon the dead subject by my intelligent pupil, Temple S. Hoyne, this has happened uniformly. The average number of intestinal perforations in eight experiments was five; the smallest number being two and the largest eight. Let us consider, then, what will be the probable consequences of this practice of M. Legouest. The moment the finger is introduced its pressure alone will be sufficient to expel a portion of the contents of the intestinal tube; but in most cases the position of the wound in the intestine will be so changed that a prolonged exploration will be necessary to determine the existence of a wound and its situation, and the fæces will continue to escape. Assuming, however, that the surgeon is successful at once in finding and securing a portion

which is wounded, he will now proceed to enlarge the external wound, if necessary, and to draw out the intestine; he will remove the contused and lacerated edges of the wound with the scissors or with the knife, apply the sutures, and return the intestine within the cavity of the abdomen.

All this must occupy some time, probably never less than half an hour; and what, in the meantime, has been happening within? While the surgeon was drawing out and handling the wounded knuckle of intestine, the contents of the remainder of the tube have been pressed back, and have been pouring out from one or more of the other wounds; and it now remains to search for these deeper outlets, and, at a time when it is plainly too late to be of any use, to secure and close them also. It will not do to say that these operations must be done with care; that, in order to encourage a hope of success, the parts must be handled with delicacy; that the opening in the walls of the abdomen must be made free by ample incisions. Any surgeon who has had experience in operations upon the abdomen knows very well how unmanageable these viscera ordinarily are when once they have escaped from the peritoneal cavity; how difficult it is to restrain their further protrusion; and how difficult it is often to reduce them again, no matter to what extent the abdominal opening is enlarged. These difficulties occur, as our experience has repeatedly proved, even when the patient is completely under the influence of an anæsthetic, although not quite to the same extent. In short, delicacy of manipulation under these circumstances is often next to impossible.

Be assured, the patient will have a better chance for life if we let him entirely alone; and it surprises us that any good surgeon could think otherwise. Serous surfaces, when brought into contact, in general adhere quickly; and if we

adopt in these cases that treatment which is best calculated to secure and maintain contact between the viscera and the walls of the abdomen, we may often encourage a hope of a successful issue.

The plan of treatment which accomplishes these indications most fully, in case a rifle, musket, or pistol ball has penetrated the intestines, is to close the external wound with a pledget of lint smeared with cerate, and to secure this in place by a broad piece of adhesive plaster; to lay the patient on his back, and instruct him not to turn or move himself in any direction, not even to raise his legs or his head by voluntary effort; and to administer to him, at proper intervals, perhaps one grain of solid opium, having in view the arrest of all peristaltic action, the reduction of pain, and the abatement of the nausea; all of which purposes are accomplished as well, and some of them better, by solid opium than by morphine. No cathartic remedies are proper, nor the simplest enemata; indeed, it is best to require that the patient should take nothing into his stomach, whether solid or liquid, except the opium, for the first twenty-four hours, since all these things tend to provoke that action in the bowels which it is most important should be for a time completely suspended. To combat the inflammation, warm water fomentations to the bowels, leeches, and bleeding are sometimes demanded.

There are certain exceptions to these rules which have generally been recognised.

If the walls of the abdomen are torn away by the missile in such a manner that the viscera are exposed, and an intestine is found to be wounded, then it will be proper to either close the wound in the intestine or to fasten by sutures the margins of this wound to the margins of the outer wound. The same practice ought also to be adopted

in case the intestine is wounded, and at the same time protruded in the form of a hernia.

Hernial protrusions of the viscera of the belly, as the result of gunshot injuries, are not so common as are hernia the result of bayonet and other penetrating wounds. The explanation of this difference is probably to be found in the fact that extravasations of the contents of the viscera are much more frequent in the former case than in the latter. The escape of the gas, especially into the peritoneal cavity, prevents that outward or centrifugal pressure which is, no doubt, the principal cause of the hernial protrusion.

If the hernia exists, and it is not complicated with a wound of the intestine, it demands the same treatment as if it was a hernia due to any other cause. In case of a recent intestinal hernia, unaccompanied with strangulation, it should be reduced promptly by careful taxis; and the efficiency of the taxis will be greatly increased by placing the patient in such a posture as to relax the abdominal muscles, and especially by complete anæsthesia. If it is strangulated, but not yet in a condition of sphacelation, no time should be lost in relieving the strangulation, and then returning it into the cavity of the abdomen. The operation will be made with the most safety by introducing into the wound a grooved director, and carrying upon this a narrow, probe-pointed bistoury. When it is practicable, the incision should be made in the direction of the fibres of the muscles, to facilitate the closure of the wound after the operation is completed. Mr. Guthrie condemns peritoneal incisions in these cases, and in cases where the omentum is protruded, on the ground that the strangulation will always be completely relieved by cutting the more superficial tissues, such as the skin, muscle, or tendinous expan-

sions; and because, in his opinion, the danger of peritoneal inflammation will be increased in proportion to the length of the incisions made in this tissue; while it is always desirable, he thinks, to secure adhesion between the intestine or omentum on the one hand, and the peritoneum on the other hand, as speedily as possible. With this view he recommends that the hernial protrusion shall be permitted to remain just within the wounded margins of the peritoneum, and "even rising up for the least possible distance" into the track of the wound. This advice might seem to possess value in case the intestine itself had been wounded and returned, but in no other case, so far as we can see. Nor does our experience in operations for strangulated hernia warrant the belief that unless it is already adherent it could be maintained in this exact position, however carefully and accurately the external wound might be closed. This practice, demanding always a very nice application of the knife, will endanger a recurrence of the hernia in some cases, especially in gunshot injuries, where the exact closure of the external wound is more difficult than in punctured wounds; and in other cases the part which has been protruded will be at once drawn away from this point, and the end desired will not be attained. Candidly, it seems to us a somewhat dangerous and wholly useless refinement of the operation for simple strangulated hernia, and one which we cannot think it proper to recommend.

Not unfrequently the surgeon will experience some difficulty in the introduction of even so small an instrument as a grooved director between the edges of the wound and the hernia; and rather than subject the hernial protrusion to much contusion in the attempt to force the instrument down, it will be advisable to commence the incision from the surface of the skin, using for this purpose a broad, con-

vex bistoury. This source of embarrassment is more often present in narrow, punctured wounds than in gunshot wounds.

We recognise the existence of incipient sphacelation in a strangulated intestine by its color and feel. If it is of a pink red color, or even dark brown, and feels firm under pressure, or if the blood, being expressed from its surface, speedily returns upon the removal of the pressure, it is not gangrenous, and ought to be returned into the cavity of the belly; but if it is of an ash color, or black; if it has a doughy feel, or crepitates under the finger; if the blood, being pressed out, does not return to the surface, it is probably dead, and must be allowed to remain where it is. When the evidence of its death is conclusive, it may be at once laid open, and then secured to the edges of the wound by a few delicate sutures; but in case of a doubt it would be better to cover it with lint spread with simple cerate, or with a soft, emollient poultice.

Where adhesions have already taken place, if recent and tender, they should be broken up; if old and strong, we can do nothing more than relieve the strangulation.

Omental herniæ demand certain modifications of treatment. When the omentum is recently expelled, and its condition of health is not essentially changed, it ought to be at once reduced; but if it is very much inflamed or swollen, or if it is ulcerated or in any degree sphacelated, it will be better, having relieved the strangulation, to permit it to remain, only protecting it by simple cerate or by emollient poultices, or other moist applications. Removal by the ligature is always improper, and excision ought only to be practised in case the protrusion is very large, or the omentum is much disorganized.

It has often been noticed that a piece of omentum, when

strangulated, is prone to enlarge or to swell rapidly, so that it would require a very free incision of the peritoneum to effect its reduction. There is much reason to suppose, also, that the introduction of such an indurated mass into the cavity of the abdomen would act essentially as a foreign substance, and cause inflammation. We think it was Sir Astley Cooper who first recommended that, under these circumstances, although the omentum might not be ulcerated or sphacelated, it ought not to be returned, but that it should be cut off close to the point of strangulation, each artery in the omentum being carefully tied, and one end of each ligature being left hanging from the wound. He hoped by this method to insure the safety of the patient, and, by leaving the omentum resting against the orifice, to secure adhesion and to prevent any future descent of the hernia, the omentum serving as a kind of stopper or plug to the canal. The advice given by Mr. Guthrie in reference to the treatment of an intestinal hernia, it will be remembered, is in effect the same—that is to say, he recommends also that the intestine shall be left within the lips of the peritoneal wound. With all respect for the opinions of these distinguished gentlemen, we object to this mode of procedure in either case. Our reasons for this objection in case of the intestine have already been given. Mr. Cooper's suggestion we have adopted in one instance, and so far from its preventing the subsequent descent of the omentum, we are persuaded that it determined an opposite result. The portion which we removed is now in the Long Island College Museum; it is nearly the size of the fist; but as soon as the external wound had closed, the remainder of the omentum began to descend, and in a few weeks the protrusion was as large as it was before the operation.

In our opinion, it will be better, having excised the

omentum and secured the vessels, to push the remnant fairly into the belly, only adopting the precaution to leave the ligatures so long that they will depend from the external wound.

Section III.—Treatment of Artificial Anus, consequent upon Gunshot and other Perforating or Penetrating Wounds of the Belly. Many ingenious plans have been devised from time to time by surgeons, for the cure of an artificial anus, most of which, no doubt, have their application in certain cases. Yet we must confess that experience has greatly modified our original views as to the urgency of the demand for surgical interference of any kind. It is our present opinion that the majority of these cases will get well spontaneously, and not an inconsiderable proportion very speedily, if simply allowed to take their own course; and we believe, therefore, that in all cases it is best to defer surgical interference for a period of several months at least.

The following examples will, perhaps, in some measure illustrate the value of these remarks:—

Case I.—*Artificial Anus closed spontaneously in eight days.*—Lewis Morell, 119th N.Y.V., received on the 1st day of July, 1863, at Gettysburg, a rifle ball, which entered four inches to the right of the umbilicus, and passed out behind, at or near the sacro-iliac synchondrosis. On the same day, having occasion to relieve his bowels, he noticed that fæcal matter in a fluid state escaped from the posterior wound. During the following eight days the same occurred whenever he took anything into his stomach. The escape of fæces by the wound then ceased, and after a lapse of eight months, when he came under our notice, this annoyance had never returned. Up to this time his bowels

had remained uniformly regular, and his health was now quite good. The anterior wound had long been closed, but the posterior wound had never ceased to discharge matter. One large fragment of bone has escaped by this opening, and it is probable that others still remain, and that this necrosed bone is the sole cause of the perpetuation of the fistula.

No treatment was ever adopted in this case except the use of cool water dressings during the first few days.

Case II.—At a meeting of the surgical section of the New York Academy of Medicine, held Nov. 28, 1863, Dr. Trowbridge, of Conn., presented a young man who had received a ball through the abdomen, and which had resulted in the formation of an artificial anus. The wounds closed at one time completely, and again opened, but finally closed again spontaneously, and now, after the lapse of several weeks, showed no tendency to reöpen. The movements of his bowels were regular, and he declared himself in the enjoyment of perfect health.

Case III.—Sergeant Hank Davy, 100th N.Y.V., was admitted into the U.S. General Hospital, at Beaufort, S.C., July 24, 1863, having been wounded by a conical ball which entered in front, just below the pubes, at the root of the penis, and escaped behind, passing through the os coccygis. The posterior wound was one and a half inches in diameter, and fæces were constantly passing at this opening. The bladder and urethra were not wounded.

Aug. 15th.—The scrotum became inflamed, and soon an abscess opened at its most depending point, and discharged fæces. Sept. 16th.—Both orifices have ceased to discharge fæces. Oct. 6th.—He was admitted into McDougall General Hospital, Fort Schuyler. He was then very feeble, and

the posterior wound was again discharging fæces; anterior wound discharging offensive pus.

Nov. 1.—Went home on a furlough, and during his absence several small pieces of necrosed bone from the arch of the pubes escaped by the anterior wound, and the posterior wound closed permanently about the middle of January, 1864, the fæcal discharges having continued in all about six months. April 18th, 1864.—He is still in the hospital, but completely recovered, except that his strength is not fully restored, and the wound through his scrotum continues to discharge about a drachm of healthy pus daily. The treatment throughout has been simple, no surgical operation or interference having been required.

Seven other similar cases have, from time to time, come under our notice, some of which will be found recorded under Section II. of this Chapter.

Cases IV., V., VI.—Surgeon C. S. Wood, U.S.V. reports in the *American Medical Times*, April 9th, 1864, three cases which came under his observation after the battle of Gettysburg, in which a complete cure has been effected spontaneously. Although it is not stated at what precise period the fæcal discharges ceased, it is inferred from the report that in none of the cases did the discharges continue longer than a few weeks. The treatment consisted mainly in the free use of opiates during the first few days, employed for the purpose of controlling inflammation and to prevent extravasations. No surgical interference was made in either case.

Case VII.—Dr. Waters, A. A. Surg., U.S.A., reports a case in which a ball entered two inches above the umbilicus, and emerged three inches from the spine; fæculent matter escaped through the posterior orifice; the patient became greatly emaciated, but both orifices healed after a

time; the posterior orifice subsequently reöpened, and again discharged fæces. Finally this man recovered completely, and left the hospital "in perfect health."*

Case VIII.—Dr. Rulison, Surgeon-in-chief to the 2d Cavalry Brigade, Buford's Division, has reported one example of wound by a carbine ball (Sergeant Gilbert, of the 1st Mich. Cavalry), in which the missile penetrated near the umbilicus and was lodged. Fæces discharged from the wound for several days, and then ceased, the wound having closed spontaneously.†

Certain cases will be presented, however, in which surgical interference will sooner or later be demanded; especially does this interference become necessary when the fistula exists in the upper portions of the alimentary tube; in which cases it is observed that the greater fluidity of the contents facilitates their escape, and the system is more seriously impoverished by the withdrawal of the alimentary substances before any considerable amount of their nutritious elements has been taken up by the lacteals.

At first there exists only an adhesion of the outer wall of the intestine to the abdominal parietes; but gradually, as the wound in the intestine cicatrizes, it becomes narrowed in its circumference, and the inner wall is made to approach the external orifice, until at length the tube forms with itself at this point an acute angle, of which the inner wall constitutes the apex, and projects so far into the external wound as to form a sort of septum between the upper and lower portions of the canal. The contents of the intestine in their descent find it impossible to double this sharp promontory, and glide outwards through the wound. The lower portion of the canal falling into disuse, becomes

* Am. Med. Times, July 4, 1863, p. 7.
† Ibid., Nov. 21, 1863.

gradually contracted through its entire length, and thus after a time presents another serious obstacle to a permanent recovery.

To these pathological changes is sometimes added, in old cases, a protrusion of the mucous membrane, resembling prolapsus ani.

If the fistula shows no tendency to close, the surgeon will first endeavor to favor this event by placing over the orifice a well adjusted pad, covered with oiled silk, so as to restrain effectually the escape of the fæces, while at the same time the pressure must not be so great as to block up and completely obstruct the natural channel.

In the event of the failure of this method, he may, in case the orifice is small, excise the edges of the tegumentary wound and bring them together firmly with sutures and adhesive plasters, adopting in this case all the necessary precautions to insure speedy union between the opposing surfaces.

Finally, when the fistula has existed a long time, and the septum projects so far as to render the reëstablishment of the original channel impossible until it has been removed, a graduated compress should be made to press fairly into the wound, until it comes to bear effectually upon the septum; or a hollow, flexible cylinder, or an elastic cylinder composed of curled hair and covered with oiled silk, may be introduced a certain number of hours each day, the cylinder being well secured from falling into the intestine by a strong ligature made fast without.

If none of these methods succeed in overcoming the obstacle, or if they occasion excessive irritation whenever they are employed, we can only adopt, as our last alternative, destruction or division of the septum by a ligature. For this purpose we employ to the best advantage a piece

of silver or other metallic wire, with which we may gradually, from day to day, increase the ligation of the portion of intestine within its grasp, and thus secure its more prompt and effectual separation. In making this operation it may be necessary to enlarge the original wound, so as to enable the operator to introduce the thumb and forefinger of the left hand, with which he will seize upon the septum, and, pressing it between his thumb and finger, determine whether he is compressing anything but this single knuckle of intestine; the needle, supported by a long and firm handle, and armed with the wire, will then be made to transfix the septum just beyond the fingers; after which, being brought out upon the opposite side, the two ends will be twisted together only very moderately, so as to make the slightest pressure, it being desirable not to strangulate the intermediate structures, but only to determine sufficient inflammation to secure adhesion between the serous surfaces. After the lapse of a few days the ligature may be tightened by a few additional turns, and in this way the surgeon may proceed until the separation of the ligature is accomplished. Indeed it would no doubt be entirely safe, after the ligature had remained in place a fortnight, to cut the septum, and thus release the ligature, with a pair of scissors.

It will now remain to close the external wound by the same operation, or by some modification of that which we have already described.

The forceps or clamps recommended by Dupuytren, and employed occasionally a few years ago, has, by almost universal consent, been laid aside as dangerous, from the rapidity and severity of its operation.

Mr. Guthrie calls attention to an instrument invented by Mr. Trant, for the purpose of pressing back the septum,

without interfering with the passage of the fæces through the intestinal canal, and which proved successful in one instance in the hands of the inventor. He thinks it deserves a further trial.

We ought not to omit also the caution given by Mr. Guthrie, not to employ excessive force in the attempt to displace the septum, lest we should cause a rupture of the adhesions existing between the parietes of the abdomen and the intestine, and thus give rise to fæcal extravasations within the peritoneum. The pain, nausea, and prostration occasioned by undue pressure will probably always give sufficient admonition of this danger.

Mr. Longmore mentions one case of permanent fæcal fistula as having come under his notice in the Crimean war. He refers also to two similar cases reported by Williamson, as among the wounded returned from India; and to one other in a private, wounded in 1840.

In the following examples, balls have entered the abdominal cavity and become lodged, but have finally made their exit by the anus :—

Case I.—In March, 1863, we saw in one of the hospitals at Louisville, Ky., Corporal English, who was wounded at the battle of Stones' river, three months before, by a large conical ball, which entered the belly on the left side, near the anterior superior spinous process of the ilium, and escaped by the rectum on the fortieth day. Matter was continuing to discharge by the rectum; he was still confined to his bed, and urination was attended with some pain, but the external wound had closed, his bowels were regular, and he seemed in a fair way for recovery.

Cases II. and III.—Surgeon Duchachet reports two cases, one in the person of a lieutenant, 14th Ind. Vols., wounded at Chancellorsville by a conical ball, which passed

per rectum on the fifth day. The ball was "very much battered and out of shape." The wound healed kindly, and a month later he went home on a furlough. The second case was in the person of a corporal of the 2d N.Y. Cavalry, who was wounded at Rockville, Md., July 28, 1863, by a conical pistol ball, which entered the back, between the third and fourth lumbar vertebræ, and passed by the rectum on the seventh day. He subsequently so far recovered as to be sent home on a furlough.*

Case IV.—Surgeon Rulison mentions one other example as having been presented in the person of a Confederate soldier wounded at Gettysburg, and who remained a prisoner in our hands. A Minié rifle ball entered just below the ensiform cartilage, and escaped *per rectum* on the second day. This man had, at the time of the report, so far recovered as to be able to walk about. The ball was considerably battered.†

Case V.—Longmore reported a case of this kind in the *London Lancet* for 1855, vol. i., p. 606, and vol. ii., p. 437, in which the patient passed both the ball and a piece of cloth. This man died of albuminuria four years after the receipt of the wound.

This is the same case to which Mr. Guthrie has referred, as the only one reported from the Crimea.

When a ball enters the rectum, just above the sphincters, it is very apt to be followed by the formation of extensive sinuses and troublesome fistulæ. Great care ought therefore to be taken in all such cases to insure a free discharge of matter by large and depending incisions.

After the battle of Manassas, on the 29th of August, 1862, our attention was called to a wound of the rectum

* Am. Med. Times, Sept. 18, 1863, p. 134.
† Ibid., Nov. 21, 1863, p. 242.

near the anus. A private in the 105th N. Y. Inf. received a ball in the left nates, which traversed the rectum and lodged itself in the right nates, and could not at first be found; but in a few days after suppuration was established, it dropped out from the anus spontaneously. An extensive abscess formed in the loose areolar tissue of this region, which continued to discharge pus and fæces for many months, forming thus a complete fistula in ano.

Section IV.—Gunshot Wounds of the Stomach.—That a ball has entered this viscus may be inferred from the following circumstances—namely, the situation of the external wounds; the direction which the projectile has taken, as indicated by various evidences; the præcordial pain; excessive prostration; hiccough; nausea and vomiting. But no positive evidence can be afforded except by the vomiting of blood and the escape of the contents of the stomach through the wounds.

The fatality of these accidents is even much greater than that of similar wounds of the intestines. Probably not one in fifty recovers; perhaps not one in a hundred.

This greater fatality is due mainly to the fact that the parallelism between the wound in the parietes of the abdomen and the wound in the stomach is more difficult to maintain, and extravasations of the contents of the stomach occur therefore more speedily and certainly, and to a greater extent. The violent contraction of this viscus, also, in the act of vomiting, can scarcely fail to force out a large portion of its contents into the cavity of the peritoneum.

In some measure the peculiar fatality of these accidents may be traced to hæmorrhages from some of the numerous and large bloodvessels with which the stomach is supplied. The records of military and of civil surgery are, how-

ever, not without examples of complete recovery after gunshot and other penetrating wounds of the stomach.

The case of Alexis San Martin is familiar to most American readers as being the person upon whom Dr. Beaumont, of the U.S.A., and Prof. Robley Dunglison, of Philadelphia, made their interesting experiments to determine the action of the gastric secretions. It possesses, however, sufficient interest in a surgical point of view, to warrant its reproduction on the present occasion. An account of the case was originally published in the *Philadelphia Medical Recorder* for Jan., 1825, but as the account is not before us, we shall quote from Prof. Dunglison's history, given in his Elements of Hygiene:—

In the year 1822 a Canadian lad, Alexis San Martin, eighteen years of age, received a charge of buckshot in his left side, when not more than one yard from the muzzle of a musket, which carried away the integuments and muscles to the size of a man's hand, fracturing and entirely blowing off the anterior half of the sixth rib, fracturing the fifth, lacerating the lower portion of the left lobe of the lungs and the diaphragm, and perforating the stomach; the contents of the musket, with fragments of clothing and pieces of the fractured ribs, being driven into the muscles and into the cavity of the chest.

When Dr. Beaumont saw the lad, twenty-five or thirty minutes after the accident, he found a portion of the lung, as large as a turkey's egg, protruding through the external wound, lacerated and burnt; and immediately below this another protrusion, which, on inspection, proved to be a portion of the stomach, lacerated through all its coats and suffering the food he had taken at breakfast to escape through an aperture large enough to admit the forefinger. We are not informed that any sutures were employed, the

treatment throughout being mainly therapeutical, with simple local applications and the occasional use of the knife in opening abscesses. Numerous complications ensued in the course of the cicatrization of this extensive wound. Abscesses formed, from which the various foreign matters were slowly thrown out, portions of the ribs exfoliated, and the patient became worn down by a long continued suppuration and febrile disturbance.

Finally, however, at the expiration of a year from the time of the accident, the wounds had all cicatrized with the exception of that in the stomach, which continued in much the same condition as it was six weeks after the receipt of the injury, the aperture being about the size of an American twelve cent piece, through which the food and drinks were constantly escaping unless prevented by a plug, compress, or bandage.

In 1833, when Dr. Dunglison made this report of his case, he was still in perfect health, feeling no inconvenience from the wound except the trouble of dressing it. He ate as heartily, and his digestion was as perfect as before the injury; he could perform any kind of labor, such as chopping wood or mowing in the field. After drinking a quart of water or of soup, by removing the compress, he could throw it out through the wound. On removing the dressings the stomach was frequently found protruding, presenting itself in the shape and of about the size of a half-blown damask rose, yet he complained of no pain, and it would return of itself, or it was easily reduced by gentle pressure.

This patient survived the injury many years longer, but we are not informed as to the precise period of his death or of its cause.

DeWitt C. Peters, Assistant-Surgeon, U.S.A., has reported the case of George H. Bowes, of the 8th Ill. Cavalry, who

was wounded near South Mountain, Md., on the 13th of Sept., 1862, by a pistol ball, in a hand-to-hand encounter with the enemy. The ball entered the abdomen above the umbilicus, and passing upwards and backwards, emerged on the back below the tenth rib. He immediately began to vomit blood, and this continued at intervals for seven days. He also passed blood with his stools. For a period of two months chyme escaped through the wound after having either eaten or drunk. He became much emaciated, but the wounds finally closed, and his health is now reëstablished; but owing to contractions formed in the healing of the track of the wound, he is bent forward, and cannot by any force straighten himself. The treatment consisted in the employment of general therapeutic remedies.

Dr. Peters relates, in the same paper, a case of punctured wound of the stomach which came under his notice in New Mexico; the wound having been inflicted with a cheese knife. In this case, also, the man recovered in a short time, without surgical interference.*

It will be observed that in these few examples which we have noticed, the recovery took place without surgical interference. But we have thus far in our reading failed to find an example of gunshot wound of the stomach in which the patient has recovered after the wound in this viscus had been closed by sutures. Of course we cannot say that such cases have not occurred, and that they have not been properly reported; yet we suspect they will be found at least to be less numerous than those in which a recovery has taken place without such interference. The advocates of the suture may very properly reply to this statement, that the infrequency of examples illustrating the value of their practice will be sufficiently explained by the infrequency

* Am. Med. Times, April 4, 1863.

of the experiment; but then if the practice does not rest upon the results of actual experiments, if these gentlemen have only propounded to us certain theories, we are at full liberty to discuss their value. This we consider that we have already done in our remarks on similar wounds of the intestines. There is no reason why these arguments, if they possess any value at all, do not apply equally in the present case. In short, we must again differ from M. Legouest, who declares that in a case of gunshot wound, "when the perforation of the stomach gives rise to an extravasation of its contents, it will be proper to enlarge the wound in the abdominal parietes, remove the extravasation from the peritoneum, and, after having revived the edges, reunite the solution of continuity in the organ by the suture rather than abandon the patient to an eventuality almost always fatal." The theory has nothing in it to commend it to our judgment; and no testimony of facts has been presented to us to alter these convictions.

The same absolute quietude must be enjoined as in a case of wounded intestine. No food or drinks should be taken into the stomach for at least twenty-four hours, except, perhaps, a small piece of ice from time to time, which may be allowed to dissolve slowly in the mouth and to pass down into the stomach, for the double purpose of checking the hæmorrhage and arresting the vomiting. As medicine, one grain of solid opium or one quarter of a grain of morphine may be given at such intervals as the symptoms may demand. Warm fomentations, and in some cases perhaps leeches or the lancet, will fulfil all the remaining therapeutical indications.

The above remarks relate only to gunshot injuries; in which class of cases we assume that the stomach is, with rare exceptions, perforated at more than one point.

If M. Legouest would limit his practice to those examples in which it can be positively ascertained that there exists but one perforation, it would be less liable to criticism.

In examples like that of Alexis San Martin, when the anterior wall of the abdomen is torn away and the stomach is actually exposed, there might, also, be less objection to the closure of the wound in the viscus by sutures; but even here the safer practice would be to secure, by the aid of sutures, the margins of the wound in the stomach to the margins of the wound in the parietes. In short, we would apply to these cases the same rules of practice which we have already recommended in wounds of the intestines.

SECTION V.—GUNSHOT WOUNDS OF THE LIVER. When a ball has penetrated this organ death generally ensues in a very few hours from internal hæmorrhage; and in the large majority of cases when, owing to the more superficial course of the missile, a fatal hæmorrhage does not occur, death follows in a few days from the supervention of inflammation both in the substance of the liver and in the peritoneum.

Occasionally, however, the patient survives a long time, or makes a complete recovery.

During the night of the 8th of June, 1853, a Buffalo city policeman, Wm. Dickerson, was shot by a pistol ball, which entered his abdomen one inch to the right of the median line, and midway between the ensiform cartilage and the umbilicus, and escaped six inches from its point of entrance on the same side of the body, between the eleventh and twelfth ribs. One hour after the receipt of the injury he had no cough, only very slight hæmorrhage, and there was no difficulty in ordinary respiration. He was pale and

somewhat prostrated. A probe, carefully introduced at the point of exit, passed fairly through the intercostal space beneath the ribs; which fact, together with the general direction of the wound, left no reasonable doubt that the ball had struck the convex surface of the liver.

The wounds were closed by adhesive plasters, but the hæmorrhage increasing, these had to be removed. During the first twenty-four hours the patient lost in this way probably a pint of blood; after this the bleeding gradually ceased. The blood was dark-colored, apparently venous. Morphine was administered, one quarter of a grain every four hours. In the evening of the first day he had great pain and tenderness over the region of the liver, and eight leeches were applied. After the leeches had drawn, warm fomentations were laid over the abdomen, and these, with the opiates, were continued several days. In a few days the anterior orifice began to discharge pus, the posterior wound having become closed very early. The tenderness gradually abated, and in a month all discharges ceased. Four months later we found him well, except that there remained some tenderness over the region of the liver.

Guthrie says that Corporal Macdonald was wounded at Quatre Bras by a musket ball, which was supposed to have passed through the liver. A copious purulent and bilious discharge followed, and on the fourteenth day there was a hæmorrhage amounting to twenty ounces. The bilious discharge finally ceased, and he was discharged convalescent on the 2d of Sept., about ten weeks after the receipt of the injury.—He also reports in detail three other cases. In the case of Lieut. Hooper, who was wounded through the anterior edge of the liver by a ball, in about five weeks he was found convalescent. A soldier of the 48th regt., wounded through the liver, was sent home with his wounds heal-

ed. An officer wounded in the battle of the Pyrenees had a fistulous discharge from the liver for several years, the ball having lodged somewhere in the abdomen, probably in the liver itself. Mr. Guthrie also informs us that he has seen three other persons wounded through the liver, to whom little subsequent inconvenience was occasioned. In the case of Lieut-General Sir S. Barns, not enumerated in the above record of examples, a portion of the rib entered and was removed from the liver. He recovered a tolerable degree of health, and survived many years.

The symptoms which characterize this accident are, in addition to the evidences furnished by the direction which the ball has taken, great prostration, due in part to the shock and in part to the hæmorrhage; sometimes a troublesome cough, with embarrassed respiration; pain referred generally to the seat of injury; but in the case of Lieut. Hooper, already quoted, the pain was in the shoulder, and he could scarcely believe at first that this was not the point where the wound had been received.

After a few days the ordinary symptoms of hepatitis supervene, accompanied with a yellow tinge of the skin and of the urine, absence of this color in the fæcal evacuations, and finally in most cases a discharge of pus, more or less tinged with bile.

The treatment consists in the employment of the usual antiphlogistic remedies, and in absolute rest.

There is less objection in these cases to an exploration of the wound than in similar wounds of the intestines or stomach, inasmuch as there is very little or no danger from fæcal extravasations. It is desirable, however, as far as possible to maintain apposition of the wounds, so as to secure the escape of the blood externally in the first instance; and at a later day, through the adhesions

which may occur, to direct the pus and bile safely to the surface.

In case the ball is supposed to be lodged in the liver, or the fragment of a rib has been driven in, it is proper to explore, and, if necessary for their removal, to enlarge the wound in the walls of the belly. The wound in the liver cannot be enlarged safely by the knife, but it may be dilated by the finger when the extraction of a foreign body renders it necessary.

Legouest removed a ball which had traversed the liver, from the back, after suppuration had taken place. "The patient got well of the wound, but succumbed a little while after from inflammation occasioned by excessive drinking."

SECTION VI.—GUNSHOT INJURIES OF THE SPLEEN. We are not aware that any one has ever seen a recovery after a gunshot wound of this organ.

It is said, however, that a soldier was found after the battle of Dettingen with his spleen protruding and covered with dirt; the surgeon cut it off, and the patient recovered. (*Notes to Chelius by South.*) A case is also reported in the 9th vol. of the Philosophical Transactions, 1737, of a man whose spleen was thrust out through a large incised wound, and being in part gangrenous, the surgeon, named Ferguson, tied a strong ligature above the unsound part, and cut off three ounces and a half of the spleen. He recovered completely. Dr. MacDonnell gives a case of excision of the spleen in the 8th vol. of the Transactions of the Medical Society of Calcutta, the patient being well two months afterwards; and another case is reported in the *Dublin Medical Press* for Sept. 18, 1844, in which the patient survived thirteen years.

SECTION VII.—GUNSHOT WOUNDS OF THE KIDNEY. These injuries are indicated by the direction which the ball has taken, pain in the cord and testes, causing retraction of this latter organ, and extending more or less down the limb of the side affected, bloody urine, and occasionally by the escape of urine through the wound.

Recoveries after this accident are very rare. A few die of hæmorrhage, a larger number from the subsequent inflammation, and some linger several weeks or months, and finally are exhausted by excessive irritation and suppuration.

Guthrie saw one case after the battle of Waterloo which seemed to promise a recovery. An officer wounded on the 9th of December, 1813, by a ball which penetrated either the kidney or the upper end of the ureter, survived at least six or seven months, and at the end of this time passed, by the fistulous orifice, a piece of cloth which had been driven in by the ball. The final result of the case is not stated, but there cannot be much doubt that it terminated fatally.

A case came under the observation of Mr. Longmore in the Crimea, where the patient survived ten days, but in the meantime extensive abscesses had formed among the gluteal muscles and down the thigh.

Legouest reports the only case which has come to our knowledge in which a cure of the wound in the kidney seems to have been established. A Russian soldier was wounded at Inkermann by two balls, one having passed through one of the kidneys, and the other through the left knee, to which latter wound he finally succumbed. The autopsy revealed the fact that "the ball had traversed the kidney from before back, through the middle of its vertical diameter. The organ had much diminished in volume, and presented upon the centre of the two opposite surfaces

a depressed cicatrix, fibrous and solid, and to which were joined, like the rays of a star, five other irregular cicatrices."

The treatment must consist in such measures as are most likely to prevent inflammation; the urine should be carefully withdrawn from the bladder whenever the urethra becomes clogged by the blood; the external wound should be kept well open, and the patient induced to repose in that position which will facilitate the discharge of urine by the wound. If the ball is lodged, or other foreign substances are supposed to have entered, it may be proper, in certain cases, to enlarge the wound, and make a careful search in order to their removal.

SECTION VIII.—GUNSHOT WOUNDS OF THE BLADDER. The danger of this class of wounds depends especially upon the extravasation of urine. The urine may be extravasated into the cavity of the peritoneum, in which case, so far as we know, it is always fatal. If, however, the wound is received below, or outside of the peritoneal reflection, the extravasation takes place into the loose areolar tissue, and the results are not so uniformly fatal.

A wound received when the bladder is empty is the least dangerous to life, provided, of course, the wound is outside of the peritoneum. It must be remembered, however, that a ball cannot pass through the abdomen horizontally, just above the pubes, when the bladder is empty, without wounding the peritoneum; but that, when the bladder is in a state of distension, it may rise so far above the pubes as to leave a considerable portion of its anterior surface uncovered by the reflected peritoneum.

Again, the recto-vesical *cul-de-sac* formed by the peritoneum does not change its position materially when the

bladder becomes distended and rises above the pubes; consequently a ball which penetrates the bladder only posteriorly and lodges, is more apt to enter the peritoneum than one which enters it only in front. A ball which passes through the body completely above the pubes, and horizontally, may not wound the peritoneum in front, but it cannot fail to wound it on the posterior surface of the bladder.

The symptoms indicating a wound of the bladder are pain, prostration, sometimes nausea and vomiting, but especially the passage of bloody urine by the wound or by the urethra. It is seldom that urine passes by the urethra unless through a catheter; and even then, owing to a large portion having already escaped through the wound, either into the cavity of the peritoneum or elsewhere, it is not usual to find more than a few drachms escaping by the catheter. There is, however, in nearly all cases unaccompanied with injury of the spinal nerves, a constant desire to urinate, as if the bladder was actually distended with urine. In gunshot wounds we do not find the urine passing by the wound so early as in punctured and incised wounds. Indeed, it is not very usual to find urine passing by the wound after gunshot injuries until after suppuration or sloughing has taken place along its track. The urine may then pass continuously, or, as is more often observed, at short intervals or whenever the bladder contracts. In other examples the urine passes more or less freely by the wound immediately after the receipt of the injury, but its discharge is soon arrested by the occurrence of inflammation and swelling, and it again passes by the same channel after suppuration has fairly set in.

The treatment is general and antiphlogistic, as in other wounds of the abdominal viscera; and opiates ought to be

employed freely, as they restrain the secretion of urine and quiet the pain and contractions of the bladder.

The local treatment consists first in the introduction of a flexible catheter through the urethra into the bladder. This ought to be introduced in all cases at the earliest possible moment, in order to prevent as far as possible any further extravasations of urine. The instrument selected should be of the largest size which can be easily introduced, and constructed with large fenestræ. The precaution should be taken also to render it quite flexible before introduction by immersing it in warm water, so that when the stilet is withdrawn, its extremity may fall by its own weight into the bas-fond of the bladder. If no water escapes, the surgeon must apply his mouth to the outer extremity of the instrument and attempt to solicit its escape by moderate suction. Having been once introduced, it should be allowed to remain permanently, only withdrawing it once in two or three days to clean it out, and to prevent the accumulation of phosphatic concretions upon its surface. No catheter should be used longer than a week in this manner without substitution, as it always becomes roughened, and it is liable to rot and to break off within the bladder. If it causes much irritation it should be withdrawn a little, to ascertain whether the irritation is not occasioned by the extremity being pressed upon the coats of the contracted bladder; but if this does not give relief, it should be replaced by a smaller instrument or withdrawn altogether for a few hours.

In some cases it will be proper to enlarge the external and most depending wound, to secure the more free discharge of urine in this direction, or to introduce a flexible catheter through the wound into the bladder, or perhaps a long narrow fillet of cloth may answer the same purpose.

The posture ought also to be such as will favor the discharge by the wound.

M. Legouest, to whose opinions we have already had occasion to allude so often while considering wounds of the abdominal viscera, recommends the employment of sutures here also, in all cases in which it is practicable to do so without exposing the patient to hazardous incisions. He recommends, however, that the sutures should not be permitted to drop into the bladder, as this would endanger the formation of calculi. For ourselves, we would prefer to reserve these operations for those examples alone in which the coats of the bladder are actually exposed, and for certain incised and punctured wounds hereafter to be considered.

We have already referred to the case of private Brownell, at present in the Central Park General Hospital, who received at the battle of Gettysburg seven wounds in various parts of his body; among these wounds were three made apparently by buckshot, which entered the abdomen above the pubes, and escaped posteriorly through the upper and lateral portions of the sacrum. Urine escaped from these wounds, both in front and behind, very freely for ten days, during which time no water passed by the urethra. On the tenth day urine ceased to flow through the posterior wounds, but continued to flow from the anterior wounds for six weeks. Several small pieces of bone have escaped from the posterior wounds. All of these wounds of the abdomen are now closed and have remained so for many months, the urine passing freely by the natural channel.

During the whole progress of the case no treatment was adopted having special reference to the injury of the bladder; the catheter was never introduced. It is not quite certain that the shot did not penetrate the peritoneum. He

is unable to inform us whether his bladder was empty or full at the time of the receipt of the injury.

Dr. Thompson, in his report after the battle of Waterloo, mentions fourteen cases which he considered in a fair way to recover.

In a large number of cases upon record, balls have lodged in the bladder and been subsequently removed by the usual operations made for stone. Mr. Ballingall, in his excellent treatise on Military Surgery, has collected nineteen of these examples; the first operation of this kind having been made as far back as 1698 by the celebrated lithotomist Frère Jacques.

CHAPTER XV.

PUNCTURED AND INCISED WOUNDS OF THE ABDOMEN.

Section I.—Superficial Wounds. Superficial incised or punctured wounds seldom require any especial attention. Rest in the recumbent posture, with occasionally the employment of adhesive plasters or of sutures, comprise all the usual means employed in the treatment of these accidents.

If the wound traverse to any considerable extent the fibres of the muscles, although the parietes may not be completely perforated, hernial protrusions are apt eventually to result. Probably this occurrence may be in some measure prevented by including the deep muscular tissues in the embrace of the suture.

Placing the patient in such a posture as to relax the wounded muscles as well as the skin, always contributes to the comfort of the patient, and may be of some positive service in preventing a separation of the wounded muscular fibres.

Section II.—Wounds Penetrating the Abdominal Parietes. Punctured or incised wounds which penetrate completely the abdominal parietes are always dangerous. It happens much oftener here than in gunshot injuries that the intestines are not wounded, and if wounded, extravasations are much less likely to occur; but still a large pro-

portion of these patients die either of hæmorrhage or of peritonitis, generally indeed of the latter.

Wounds of the great arterial and venous trunks within the abdominal walls are almost inevitably mortal; in only a very few instances of wounds of the iliac arteries an opportunity being presented for the application of a ligature. Wounds of the mesenteric vessels are still more certainly fatal; and it is only in examples of wounds of the more superficial vessels, such as the external or internal epigastric, the circumflex ilii, etc., that surgical interference is generally of much value.

In these latter cases it will be proper always to attempt to secure the bleeding vessel by a ligature; and for this purpose, if necessary, the walls of the abdomen should be freely opened until the vessel is found.

We desire to mention, however, that we have once wounded the epigastric artery while operating for the relief of ascites, and that the hæmorrhage was made to cease by pressure. The circumstances, as well as we can remember, were as follows:—The abdomen was greatly enlarged with the serous effusion; owing to the great distension of the parietes, and partly also to the fact that the patient was lying upon her side, the instrument, a trocar, was inadvertently carried about two inches to the left of the median line—a few inches below the umbilicus. The water escaped freely and without being colored with blood. As the canula was being slowly withdrawn, however, and when its extremity had fairly escaped from the peritoneal cavity, but was still held by the muscles and skin, a clear bright-red stream of blood began to flow through the instrument. The stream nearly filled the canula. It was at once apparent what had happened, but an occurrence so unexpected left us for a moment undecided what course to adopt.

Pushing the canula fairly into the cavity again, it was observed that the stream of blood ceased at once, and that colorless serum again escaped. This happily confirmed our suspicion that the vessel was lying so far from the peritoneum in the substance of the rectus muscle that it had not emptied itself into the peritoneal cavity, and perhaps might not if the canula was withdrawn. While we were deliberating, and before the canula was carried back into the belly, the patient had lost over a quart of blood. The instrument was now withdrawn, and the external bleeding at once ceased almost entirely. A graduated compress was prepared and laid directly over the wound, and this was secured in place by a broad and firm bandage.

On the following day a slight bleeding occurred, from the bandage having become displaced while the patient was asleep, but it never returned; and after two months we found this woman in as good health as before the operation, having suffered no farther injury from the wound than has already been stated.

Mr. South, in his notes to Chelius's Surgery, has collected no less than five examples in which bloodvessels have been wounded in tapping, in three of which death resulted. In all except one the vessel wounded was supposed to be the epigastric, and Mr. South thinks that it is especially the external epigastric which has in these cases been wounded, which sometimes is known to approach quite to the median line. In none of the cases reported does it appear that any attempt was made to arrest the bleeding. Mr. South suggests that a wax taper or a stiff bougie should in such a case be pressed into the wound; and this suggestion might receive encouragement from the fact that in our own example the presence of the canula, when it was fairly in the peritoneal cavity, arrested the bleeding; but it is not

stated that this practice has ever been actually adopted, and we can well see that it is liable to the objection of leaving a foreign substance in the cavity of the belly; an objection which ought not to weigh perhaps against the danger from a continual bleeding, since some have even recommended and practised leaving flexible tubes in the opening to perpetuate the drain of serous fluids; not with such results, however, as to warrant its repetition by ourselves.

Mr. South also suggests that the wall of the belly may be raised into a fold and compressed for some hours. In our opinion firm and well graduated pressure would be more likely to succeed. Yet after all, we cannot think that the surgeon ought ever to trust to either of these methods if the circumstances render it practicable for him to tie the bleeding vessel. In no other way can he make sure that the hæmorrhage, which no longer appears externally, is not going on within.

SECTION III.—WOUNDS PENETRATING THE ABDOMINAL WALLS, UNACCOMPANIED WITH WOUNDS OF THE INTESTINES, BUT FOLLOWED BY HERNIA. It has already been observed that punctured wounds are more liable to be followed immediately or very soon after the occurrence of the accident, by hernia than gunshot wounds; which circumstance we have ventured to ascribe to the fact that the intestines suffer lesion less often in the former; the escap of the contents of the intestine into the cavity of the peritoneum being supposed to have some influence in preventing the outward pressure of the walls of the intestine.

In case the omentum or the intestine has escaped externally, and it is not wounded, the same rules which we have given for the treatment of these accidents in gunshot

wounds will be applicable here, only that it will be prudent to take this one additional precaution, namely, after having reduced the omentum or the intestine, the wound should be closed by sutures introduced through nearly the whole depth of the muscular parietes, in order to prevent a recurrence of the hernia. In reducing the hernia, also, the surgeon must take care that he does not thrust it laterally between the muscular plates. Dr. Hutchison, of Brooklyn, has reported to the New York Pathological Society one example of this unfortunate mistake which resulted fatally.

Of this class of wounds, we have met with a large number in the course of our practice, a majority of which, we are inclined to think, have terminated fatally. We have no satisfactory records, however, of any except the two following cases, both of which resulted in death:—

On the 15th of Nov., 1861, Scott, a private in the 31st N. Y. Vol., Inf., was stabbed with a small sword by his officer in command. Scott was intoxicated, and the wound was inflicted while the officer was attempting to place him under arrest for insubordination.

The point of the weapon entered a little to the right of the umbilicus, penetrating completely the walls of the abdomen, but not wounding the viscera. The surgeon immediately closed the wound with adhesive plaster and a compress, with a bandage, and placed the patient upon his back, with the body flexed. During the night he was very restless, and a portion of intestine became protruded. On the following morning we found a knuckle of intestine projecting from the wound of about six inches in length, completely strangulated, and of a dark brown color. The patient was pale, almost pulseless, and constantly vomiting. After having administered chloroform, we enlarged the

opening with a probe-pointed bistoury and reduced the hernia. The wound was then closed with sutures, lint, a compress, and the whole secured with a bandage. Perfect quietude was enjoined, and, under the influence of opium and morphine, his restlessness, pain, and vomiting gradually ceased, but the peritonitis was not arrested, and on the morning of the 19th he died, having survived the injury three days and a half.

The autopsy revealed the fact that there was no wound of the intestines and no internal hæmorrhage, but the peritoneal cavity contained abundant serous, fibrinous, and purulent effusions.

It is proper to remark that the occurrence of the hernia after the first dressing suggests the importance of closing these wounds at once with sutures, or in such a manner as to effectually prevent the escape of the viscera.

On the 28th of August, 1853, James Stewart, aged seven years, was wounded in the belly by a scythe; the scythe making a transverse incision above and to the right of the umbilicus of about four inches in length. The intestines and omentum were immediately protruded. The attending surgeon made repeated attempts to reduce the hernia without the aid of an anæsthetic, but failed. Seven hours had elapsed when we first saw the patient. The hernia, including probably twenty inches of the small intestines and a considerable omentum, was of a dark pink color, but not highly congested. The patient was vomiting and very much prostrated. Having placed him completely under the influence of chloroform, and having enlarged the opening slightly, the reduction was soon accomplished. As in most other similar cases, it was noticed here that, notwithstanding the anæsthesia was complete, the intestine could not be reduced in mass, but that it had to

be returned by pushing in one arm of the protruding knuckle while the other arm was prevented from constantly escaping by holding upon it with the thumb and forefinger of the opposite hand. After the reduction, the wound was closed with sutures, adhesive plasters, and a compress. The vomiting continued as before.

The patient was then left in charge of the attending surgeon, with a suggestion that as soon as moderate reaction should occur, if accompanied by considerable abdominal tenderness, the patient should be bled, and that he should be kept quiet with morphine. The parents, it was subsequently ascertained, preferred to take the case into their own hands, and adopted no other treatment than the application of cold water fomentations to the abdomen.

Peritonitis supervened speedily, and the boy died on the third day.

The practice of applying cold in the treatment of peritoneal inflammation has already been condemned, but the result might not have been different under the most judicious management.

Raphael reports two similar cases as having been presented in the wards of Bellevue Hospital, both of which terminated fatally.*

Section IV.—Wounds Penetrating the Abdominal Walls, and accompanied with Wounds of the Viscera. A simple incised or punctured wound in the intestine, which is not more than two lines in extent, such for example as might be made by a small penknife, is frequently found to be entirely closed by the protrusion into the lips of the wound of the internal or mucous membrane, so as to prevent pretty effectually the escape of the contents

* Am. Med. Times, Feb. 21, 1863.

of the tube; yet it must not be supposed that this will always happen. We have seen a punctured wound of an intestine made by a pocket-knife prove fatal by extravasation; and if the wounded portion is actually protruding, it will be best, as a general rule, to make it more secure by inserting a very fine suture, made of dentist's silk, cutting off both ends very closely before the intestine is returned.

In the two following cases it is probable that small punctured wounds of the intestine existed, resulting in recovery without surgical interference.

Thomas Shepard, æt. sixteen, was admitted to the Buffalo Hospital, June 15, 1849, having been stabbed eight hours before with a butcher's knife; the weapon having entered on the left side of the abdomen, near the anterior margin of the quadratus lumborum, and midway between the last rib and the crest of the ilium. The wound had been probed freely before he came under my notice, and was ascertained to be four inches in depth, passing directly in towards the intestine. I need not say that this exploration was improper, but the depth and direction of the wound rendered it very probable that an intestine was wounded. The wound bled freely at the time, and although it was immediately closed after his admission, the bleeding was not easily restrained, and we were compelled to open it again and dress it lightly with lint, etc. He was ordered to take opium, one grain every four or eight hours, according to the necessity—to remain quiet on his back, and to take no food or drink.

On the fourth day we opened his bowels with castor oil. He continued to improve, there having been at no time anything more than a slight tenderness of the abdomen; and on the eighteenth day we removed a large plug or mass of

fibrin which had gradually pressed itself out towards the external orifice of the wound. In a few weeks more the wound was closed, and he was discharged cured.

—— Vincent was admitted into the Buffalo Hospital of the Sisters of Charity on the 3d of Oct. 1857, having been stabbed two weeks before in the right side, a little below the margin of the ribs, with a dirk. The wound had been closed with adhesive plaster, but beyond this no treatment had been adopted. On the eleventh day the wound opened spontaneously and discharged fæcal matter freely for two or three days; when admitted it was discharging only pus. The treatment adopted from this time forward was chiefly sustaining; the suppuration gradually ceased, the escape of fæcal matter never being renewed, and in about three months he was discharged cured.

In the two following cases similar accidents resulted in death:

J. H., of Niagara Falls, N. Y., was stabbed with a pocket-knife on the 17th of Dec. 1857; the wound, which was a little below the umbilicus, was three-quarters of an inch in length. Almost immediately after the receipt of the injury a portion of omentum protruded. Dr. Ware, of Niagara Falls, reduced the hernia and closed the external wound with adhesive plaster. The patient was kept in bed and placed moderately under the influence of morphine. Acute peritonitis supervened, accompanied with retching and vomiting of blood and other matter, and he died in thirty hours.

The autopsy showed that an intestine had been wounded.

On the 24th of August, 1849, Michael Rush, æt. twenty, was stabbed with a pocket-knife four inches below the umbilicus, and a little to the right of the median line. The wound was only one-quarter of an inch in length, yet from

it was protruding a portion of omentum of the size of a hen's egg. The strangulation was so complete and had existed so long, that I thought it proper to excise the protruding mass, which was accordingly done; and the vessels being secured, the neck was pushed back, and the wound carefully closed, leaving the sutures hanging from the wound.

The subsequent treatment consisted in abstinence from all fluids or solids, perfect rest, and the free use of opiates.

This man died in twenty-four hours; and the autopsy showed the existence of a wound in the intestine, from which a small amount of fæcal matter had escaped. This condition had been accompanied, also, with active peritoneal inflammation.

In case the wound of the intestine is more considerable, and the intestine lies outside of the walls of the belly or is in plain sight, even though it does not protrude, it must be closed carefully by fine silk sutures. The sutures employed in these cases have been much modified by different operators. Perhaps the most common practice has been to use what is known as the "interrupted" suture, introducing them at intervals of two or three lines, cutting off the ends closely, and leaving them to find their way after a time into the intestinal canal. In the only example in which we have adopted this practice the patient died. The case is as follows:

A young man was stabbed in the belly with a large knife or dirk on the 12th of November, 1853. He was seen within one hour from the time of the receipt of the injury. We found a wound two inches above the pubes, two inches and a half long, and from which had already escaped nearly half of the small intestines and a small portion of the omentum. A wound was discovered in the intestine

half an inch in length, and from which fæces were escaping.

Laying the patient upon his back, and having administered chloroform very freely, we first closed the wound in the intestine with three fine silk ligatures, turning the serous surfaces in, so as to bring them in contact, cutting off the ends of the ligatures close to the knots. Subsequently the opening in the walls of the belly was enlarged very slightly; after which the intestine was reduced easily. The external wound was closed with five or six sutures, adhesive plaster, and a bandage. Soon after this the patient was bled one pint; opium was given freely, and perfect quiet was enjoined.

On the following morning his abdomen was tender and tympanitic, and his pulse sharp. He was bled again to the same amount, or until it produced a partial syncope, and the opium was continued. During the day, the pulse having again become more wiry and the symptoms of peritonitis still advancing, he was bled again freely from the arm. He died the next day, having survived the injury about forty-two hours.

The autopsy showed that extensive peritonitis had existed, sufficient, no doubt, to have been the immediate cause of his death. There was no extravasation of blood or of the contents of his bowels into the peritoneal cavity; but the sutures had partially given way, and no adhesion had taken place between the intestine and the inner wall of the belly. It was apparent, therefore, that extravasation would soon have taken place, and that he would sooner or later have died from this cause.

With our present experience in relation to the closure of an artificial anus, having observed how readily and frequently these fistulæ close spontaneously, we do not hesi-

tate to say that we would prefer either stitching the margins of the wound in the intestine to the external wound, or closing the intestinal wound with a continuous suture, bringing the ends of the suture out and making them fast, so as to retain the wound of the intestine in apposition with the wound in the parietes. If the first method is adopted, the external wound will be permitted to remain open, and a temporary fistula will be almost inevitable; if the latter method is adopted, the external wound will be closed, except so far as it is prevented from being closed by the presence of the suture; and if the wound in the intestine does not unite, an external fistula may save the patient from the dangers of extravasation.

Dr. Scott has reported an example of wound of the stomach, unaccompanied with protrusion, and which had been made by a small sword, in which the patient recovered without surgical interference.*

S. W. Gross, Surgeon U.S.V., has reported a very interesting case of complete recovery from a sword wound of the descending colon. The weapon entered the back, and soon after the receipt of the injury a surgeon gave the patient a portion of castor oil, and followed this with sulphate of magnesia, which occasioned copious watery discharges which passed almost entirely by the wound. Surgeon Gross saw the man one year after the injury, and he was then well.†

Travers tied a ligature around a protruding wound of the stomach and the patient recovered. The ligature was never found, but probably passed by the rectum.‡

* Chelius's Surgery, with Notes by South, 1st Amer. Ed., vol. i. p. 552.
† Am. Med. Times, March 19, 1864.
‡ Chelius, vol. i. p. 523.

CHAPTER XVI.

GUNSHOT WOUNDS OF MALE ORGANS OF GENERATION.

Section I.—Gunshot Wounds of the Penis. These accidents involve the danger of a troublesome hæmorrhage, especially when the corpora cavernosa are wounded; of extensive urinary infiltrations into the areolar tissue of the penis, scrotum, and perinæum; of the formation of permanent urethral strictures, and of contractions, with consequent deformity of the penis.

The hæmorrhage from the corpora cavernosa is not so likely to occur as a primary accident after gunshot injuries, as a secondary accident—the result of sloughing or of ulceration; when it occurs immediately after the receipt of the injury, and does not cease spontaneously, or upon the application of cold lotions, the surgeon may resort to the perchloride of iron as a direct application, or to the actual cautery, if required. In other cases it will be more convenient, perhaps, to apply a ligature, or several ligatures, in succession, with the aid of a needle, in such a manner as to include more or less of the open cellular structure. In this manner we have once succeeded in arresting a hæmorrhage of this character. Finally, if other resources fail, a female silver catheter may be introduced into the urethra, and the penis may be compressed with a narrow roller.

The secondary hæmorrhages will be treated most successfully by cold applications, posture, perchloride of iron, and

in some cases also pressure may be employed in the manner already indicated.

Extravasations of urine will be avoided by the timely introduction of a catheter, and by free external incisions. The surgeon ought to be constantly on the alert to detect the existence of extravasation when it has actually taken place, and which may be indicated only by the gradual spread of redness and tumefaction towards the scrotum, or in other directions; and whenever these signs are present, or there is even a reasonable ground of suspicion that urinary extravasations have taken place, no time should be lost in making free incisions. Very little harm can result from too early or from unnecessary use of the knife; but irreparable mischief, and even fatal consequences, often ensue upon a few hours' ill-timed delay.

The tendency to the formation of urethral strictures and of contractions of the body of the penis are greater, perhaps, in this class of accidents—that is in gunshot injuries—than in almost any others, in consequence of the sloughing and actual loss of structure which occurs so constantly in the track of the wound; but we may often greatly diminish the gravity of the stricture, and sometimes prevent its occurrence altogether, by the persistent use of the flexible catheter or the sound. In order to accomplish this, however, the use of these instruments must be continued long after the wounds have closed, and until all further tendency to contraction in the urethra has entirely ceased.

McK——, a private in the 94th N.Y.V., was wounded at the battle of Manassas, Aug. 29, 1862, by nine buckshot, one of which penetrated the glans penis, near its extremity, splitting it in two; there were also two other holes through the glans made by other shot. When admitted to the hospital the urine escaped by three orifices, two of which

closed spontaneously in a short time. In order to cure the slit in the end of the penis, the surgeon in charge made raw the edges of the fissure, and then brought them together with sutures. The result was a complete restoration of the form of the organ.

In the course of our practice we have met with examples of hypospadias or deficiencies of the lower wall of the urethra, but in which the natural channel of the urethra remained open, occasioned by chancres, and in which the repeated application of nitrate of silver as a caustic has served to accomplish a cure; but cases will be presented occasionally, and especially as the result of gunshot injuries, which will require the use of the knife and sutures, a catheter being kept in the urethra during the progress of the cure, both to prevent extravasations of urine, and to obviate the formation of a stricture.

In the number of the American Medical Times for March 19th, 1864, Surgeon S. W. Gross, U.S.V., reports the case of a conical ball encysted in the right cavernous body of the penis. The ball was received at the battle of Shiloh, April 7, 1862, and was found by Surgeon Gross lying about one inch from the pubes. A good deal of inflammation followed the injury, but at the end of two years it gave him no pain, and he could not be persuaded to have it removed.

Our attention has been called several times to examples of retraction and consequent deformity of the penis, occasioned by the loss of more or less of the tegumentary coverings, and by the consequent cicatrization. Most of these cases are wholly irremediable.

Section II.—Gunshot Wounds of the Scrotum and Testes. These accidents present a great variety of com-

plications, such as inflammation of the scrotum, bloody, serous, and purulent infiltrations into the cellular tissue of the scrotum, with sloughing, inflammation, and swelling of the testes, fungous growths from the interior of the testes, hernia of the seminal ducts, seminal fistulæ, atrophy of the testes, and inflammation of the cord.

The treatment must be conducted upon those general principles which the intelligent surgeon cannot fail to understand. Infiltrations require free incisions; inflammations of the testicle demand rest in the horizontal position, elevation and support of the organ, and warm poultices or fomentations; cold applications are generally painful when applied to the testes; fungous growths are to be repressed by pressure, astringents, and caustics; hernia of the seminal ducts can only be controlled by carefully graduated pressure; seminal fistulæ are seldom cured, but in most cases ultimately occasion atrophy, or render castration necessary.

A very interesting and instructive example of gunshot injury of the penis, scrotum, and testes, is reported in the number of the American Medical Times for Oct. 17, 1863, in which extensive destruction of the scrotum ensued, and a flexible catheter having been broken off in the bladder, was successfully removed by Surgeon C. S. Muscroft, U.S.V.

A private in the 5th N.Y.V. was wounded at Manassas, Aug. 29, 1862, by a ball which passed through his right thigh and then through the corresponding testicle. A few weeks after the accident we found him in one of the hospitals at Washington, the wound in his thigh having closed, but the testicle had become almost completely atrophied, and continued to discharge a little matter through a fistulous orifice. The fact had not been positively ascertained, but we have no doubt the fistula was seminal.

In the same hospital (Rev. Dr. Smith's church) we saw a second case wounded in the same manner through the thigh and testicle, the testicle being less atrophied but throwing out a prolific fungus.

On the 30th of July, 1861, we saw in the Seminary Hospital at Georgetown, a private from the 79th Pa. V., wounded by buckshot in the scrotum, but in which case very moderate inflammation had ensued, the shot not having penetrated the testicle.

Col. ——, of the cavalry, was wounded near Brentwood, Tenn., by a ball which traversed the scrotum and the body of the penis near the root. When we visited him in Nashville, Tenn., on the 20th June, 1863, a few days after the injury, we found very little swelling, and the catheter was retained in the urethra without much inconvenience.

The following is an example of contusion of the cord from a ball which, after entering the skin, was deflected in a somewhat remarkable manner:—

Alex. J. Dougherty, private, 13th Ind. Vols., was wounded Nov. 2, 1861, near Holly Creek, Va., by a round ball, which entered near the top of the left trochanter major, and passing across in front of the pubes, became lodged under the skin of the right thigh, at a point a little below its middle, and upon the outer aspect of the limb. At the time he was seen by us eleven months had elapsed, and he was on duty with his regiment at Suffolk, Va. The ball could be distinctly felt very near the surface, in the position which we have described, but as it gave him no inconvenience he declined to have it removed.

When he was wounded he felt first a sharp pain over the bladder, and subsequently on the inside of the right thigh and testicle. The testicle occasionally becomes swollen.

CHAPTER XVII.

GUNSHOT FRACTURES.

We shall confine ourselves in this chapter to a brief consideration of the prognosis and treatment of those gunshot fractures in which neither resection nor amputation has been practised.

SUPERIOR MAXILLA.

All fragments of the superior maxilla which are not completely detached or greatly comminuted, should be at once replaced and maintained in position as well as possible by either closing the mouth, or by wire ligatures made fast upon adjacent teeth, or by such other means as the circumstances may suggest; experience having demonstrated the facility with which a bony union of these fragments is usually effected, even in the most unpromising cases.

INFERIOR MAXILLA.

The remarks which have been made in reference to fractures of the upper jaw have an equal application to fractures of the lower. With care and attention, in the majority of cases, most of the fragments may be saved. It is seldom, however, that bandages can be applied at a very early period; nor will a delay of a few days usually prevent the final and more accurate adjustment of the fragments.

When at length external supports can be applied, the

surgeon may employ the simple four-tailed bandage, or an external splint made of gutta-percha, leather, felt, or the plaster-of-Paris bandage, constructed with fenestræ, wherever an external wound renders this necessary, and held in place by bands secured across the top of the head. If an internal or interdental splint is demanded, small pieces of gutta-percha will be found to answer the purpose best.

In some cases it will be necessary to wire the teeth, or even the fragments of bone together.

To correct the excessive fœtor occasioned by the saliva and pus in the mouth, a weak solution of tincture of myrrh in water will be found sufficient. With this the mouth should be rinsed often.

CLAVICLE.

Having removed the small and floating fragments, and dressed the external wounds with cloths wetted in cool water, it only remains to suspend the forearm and arm in a sling made of a handkerchief, or of a broad piece of cotton roller. To apply, in these cases, any of the complicated dressings, or to attempt to carry the shoulder outwards and backwards by a pad in the axilla, or by any other form of apparatus, is worse than useless; it is actually mischievous.

If the patient is obliged to recline, the best position for him to take, having reference only to the fracture, is upon his back.

Bony union is generally accomplished, but with some shortening and deformity. We have observed, however, that neither the shortening nor deformity is in itself a source of maiming. Even when the clavicle unites only by ligament, the limb is, in most cases, nearly as strong and as useful as it was before. The exceptions to this rule

are found mostly in those examples where the axillary plexus has suffered from the original injury.

HUMERUS.

In case a ball has entered the humerus near the shoulder-joint, and it is proposed to save the arm without resection, the external wound should be made free, the small loose fragments should be picked out carefully, and for the rest the case should be treated in the manner best calculated to prevent inflammation. Sutures, adhesive straps, bandages, and splints are inadmissible. Absolute rest and cool water lotions are the important remedial agents.

If the shaft is involved in the fracture at any point above the base of the condyles, the fragments will require some support. It would be well, indeed, if splints could be applied firmly, as in simple fractures, but such is not usually the fact; and the truth is, that in general too much has been attempted; the bandages have been applied too tightly and perseveringly, and sometimes at the sacrifice of the limb.

We employ usually in these cases a single splint, made of felt, leather, or gutta-percha, long enough to extend over the top of the shoulder on the one hand, and to the lower part of the elbow-joint on the other, and broad enough to encircle one-third of the circumference of the arm. By moulding or otherwise fitting the upper part of the splint over the top of the shoulder, it will be prevented from becoming displaced downwards. Before being applied, the concave surface should be padded with cotton or tow, and covered with a piece of cotton cloth stitched along the back of the splint.

This splint should be secured in place by a few light turns of a roller, and never applied so tightly as to endan-

ger congestion of the limb below, or to render necessary the application of a roller to the hand and forearm.

If this cannot be borne, or if it is found inconvenient, from the position and size of the wounds, the limb must be simply laid upon a properly shaped and sufficiently firm pillow, the application of splints being reserved to a later day.

ELBOW-JOINT.

Gunshot fractures in the vicinity of the elbow-joint—for example, fractures at the base of the condyles, through the condyles or in the upper portions of the radius and ulna—are generally followed speedily by great swelling beneath the integument and among the muscles, and by effusions into the capsule of the joint itself, unless indeed there is a free external opening for the escape of these effusions.

Anchylosis, more or less complete, is the result in nearly all of these cases; it is necessary, therefore, that the forearm should be kept at a right angle with the humerus, as this is the position in which an anchylosed arm is found to be most useful.

Splints and bandages are in general useless or actually hurtful. The patient reclining upon his back, should have the limb supported carefully on a board covered with a soft pillow.

A frame may be made of stout iron wire and bent to accommodate the arm and forearm; which, being covered with cotton cloth and a piece of oiled silk, constitutes a very comfortable and convenient support for the entire limb. We are at this moment using a support of this kind at Bellevue Hospital, in a case of exsection at the elbow-joint, the apparatus having been constructed by Dr. Brownell, one of the House-Surgeons.

If the patient is walking about, at a later day, a right-angled splint, well padded, may be secured to the back of the arm and forearm, the whole being supported by a sling.

In order to prevent or diminish anchylosis, passive motion should be given to the joint at the earliest practicable moment.

RADIUS AND ULNA.

Where only one bone is broken, nothing can be gained by the use of splints during the first few days. It will be sufficient if the arm is supported in a sling, or laid upon a pillow.

In case both bones are broken, the patient ought to be kept in the recumbent posture upon his back, with the forearm resting upon a pillow, supported by a board, extended and supinated. No attempts should be made to lengthen the limb by apparatus, but daily attention should be given to the position of the bones, and, as far as practicable, they should be kept in line. It is impossible to control or force outwards the fragments by any pressure between the bones.

Union will in general take place, but with some deformity. The power of pronation and supination will be in a great measure lost. If the bones during treatment are kept rotated upon each other, the power of supination and pronation will be completely lost. When the body occupies the supine position, and the arm is extended laterally, the forearm and hand being supinated, the radius and ulna are parallel. If, therefore, the patient is kept upon his back, so that the position of supination in the forearm can be maintained, the power of rotation may be in some measure preserved.

If the patient walks about, the forearm must be laid

upon a cushioned board, suspended by straps across the opposite shoulder. The forearm being flexed to a right angle with the body—as it must be when the patient is walking or sitting—the radius and ulna are found to be parallel when the forearm rests upon its ulnar margin, or midway between supination and pronation. This is the position, therefore, which in this case we desire to maintain, as it is the position most likely to preserve the power of rotation; in simple fractures this can be easily accomplished, but in compound, and in gunshot fractures generally, it is difficult to prevent the hand and forearm from assuming the prone position, when the elbow is bent to a right angle. Supination is impossible in this position, and the arm will not generally remain in repose upon its narrow ulnar margin.

After the lapse of some weeks, more accurately adjusted supports may be employed.

WRIST-JOINT.

Anchylosis is even more certain to ensue upon gunshot injuries of the wrist than of the elbow-joint; a result which is due, in the case of the wrist, quite as much to the inflammation which invades the numerous tendons, obliterating their synovial surfaces, and binding them together in one common mass, as to the direct injury done to the joint. The limb must not, therefore, be confined by splints or bandages, but being made to repose upon a soft and well fitted support, all proper means should be employed to prevent inflammation; and, at the earliest practicable period, the joint should be subjected to gentle, passive motion. During the whole of the treatment the fingers should be left at liberty, and they should be occasionally flexed and extended, or they will become anchylosed also.

FINGERS.

When a single finger is broken, a splint composed of gutta-percha, felt, or binder's-board, should be moulded to the palmar surface of the entire length of the finger, the finger being moderately flexed. Before applying the splint a piece of patent lint, or some other soft material, may be laid against the skin. A narrow roller should now be applied with just sufficient firmness to retain the finger and splint in place.

If several fingers are broken, the splint ought to cover the whole palmar surface of the hand, but it should not confine the wrist-joint.

The fingers, in this case also, must be kept in a flexed position, since, if anchylosis occurs, any other position would render them less useful.

THIGH.

We have not in our possession full statistics of the present war, but sufficient facts have come to our knowledge to indicate that there has been on the part of our surgeons a large amount of conservatism, especially in reference to the treatment of gunshot injuries of the thigh. Our own impression is, that in these injuries conservatism has ruled too much, and that amputations have been too little practised. Up to a recent period there have been recorded in the Medical Bureau at Washington 20,930 wounds, of which 740 were compound fractures of the femur; and of this number only 269, a little more than one-third, had been submitted to amputation before being removed to a General Hospital. If we include those who died on the way, or were not in a condition to be moved, the proportion of those in whom an attempt has been made to save the limbs, would probably be quite two-thirds. Of the knee

there were 242 wounds, and of these 138, or more than half, were not amputated before being sent to General Hospital.

We have seen in the various hospitals of the United States army many hundreds, probably thousands of broken thighs under treatment, and a certain proportion of these had already united, making tolerably useful limbs.

We have made notes of seventy-five cases which have come under our special notice, from which the following observations are drawn:—

Case.—*Fracture of the Neck of the Femur—Recovery.*—James Vanderbeck, æt. 21, was wounded at Chancellorsville, May 4th, 1863, by a rifle ball which entered just above and behind the left trochanter, and passing forward in the direction of the neck of the femur, emerged in front through the left groin. This man remained in the hands of the enemy eleven days, and was then exchanged; at no period of time was extension or counter-extension employed, or splints applied. No fragments of bone have escaped.

Seven months after the receipt of the injury the limb was found shortened one and a half inches, the toes were everted, and the patient walked only with crutches. When the limb was rotated a clicking sensation was produced in the neighborhood of the joint, as if the fragments had not united. The wound closed at the end of about three months.

Two similar examples of gunshot fracture of the neck of the femur are reported by Act. Asst.-Surg. Miles, as having recovered, with bony union, in the number of the *American Medical Times* for July 11th, 1863. In one of these cases several fragments of bone were exfoliated. One was shortened one inch and a half, and the other three-quarters of an inch.

Of the seventy-five examples recorded, only five were fractures of the upper third of the shaft; and of these one

died, one was likely to die, and the remainder were united and seemed to promise complete recovery. All of the three last were still discharging pus. In the first of the three last mentioned, four months had elapsed; the limb was shortened one and a half inches, and very crooked; no splint had ever been employed. In the second, four months had elapsed; the limb was shortened three inches and a half, and only slightly bent at the seat of fracture; a straight splint and Smith's Anterior Splint had been employed at successive periods. In the third, nineteen months had elapsed; the limb was shortened one inch and a half; it was nearly straight, and the patient was walking with a cane, with only a slight halt; a straight splint had been employed.

After a careful examination of the remainder of our notes, we find in them too many inaccuracies and omissions to render any farther statistical enumeration valuable. We shall therefore only state farther, that in no case where the patient had survived three months, had the bones refused to unite; in nearly all cases the limbs were more or less crooked, but in a few they were nearly straight; the average shortening was probably from two inches to two and a half; union had occurred most promptly where there was the least comminution, and where no fragments had been exfoliated during the progress of cure; in the majority of cases where union had taken place, even after the lapse of a year or more, suppuration still continued, giving evidence of the presence of necrosed bone; there was no very marked difference in the results, so far as the form and length of the limb are concerned, whether the limb had been treated by one form of apparatus or another; in two or three cases the results were nearly or quite equal to the average where no splints had ever been employed, the fact

of the existence of a fracture not having been recognized until the union had been accomplished; but whatever difference was especially noticed seemed to indicate that the straight position, with moderate extension, possessed some advantages, at least in so far as the length and form of the limb were concerned.

We regard the results obtained in these seventy-five cases as, on the whole, favorable; but they must not be taken as a safe ground for prognosis in all cases of gunshot fractures of the thigh, when it is proposed to attempt to save the limb. We have only presented a view of those examples in which the patients have survived the injury several weeks or months; we have no means yet of ascertaining in how many cases the effort has been made and has failed, the patients having died after the lapse of a few days or weeks. We have seen multitudes of these unfortunate examples, in many of which we have had occasion to regret that the surgeon had not seen fit to make an early amputation. Moreover, it is certain that many of the cases recorded as having recovered, will eventually terminate in amputation or in death. In short, we must still leave this important question of the relative safety of amputation, or of attempts to save the limb, in a great measure unsettled. It is probable, also, considering the difficulty of obtaining reliable statistics, and the number of conditions which must enter into the calculations, that no absolutely definite conclusions will ever be reached.

We are prepared to say, however, that the surgeon ought not to attempt to save the thigh after a gunshot fracture, when any of the following conditions obtain.

When the patient has to be carried far over rough roads and without adequate support to the limb.

When the bones are greatly comminuted.

When the patient suffers great pain, or violent spasms continue in spite of opiates and rest.

When the soft parts have suffered great contusion, as in case of a fracture from a solid shot or shell.

When there is very extensive laceration of the soft parts.

When the principal arteries or nerves are involved in the injury.

When the fracture implicates the knee-joint, or even when it is near the knee-joint; experience having shown that amputations near the knee-joint give a better percentage of recoveries than any other thigh amputations; while, on the other hand, attempts to save the limb in these cases give a worse percentage of success than in any other fractures of the thigh.

Under the following circumstances we would not, as a rule, resort to amputation:

When the ball has entered the head, neck, or trochanteric portion of the femur. Owing to the more spongy nature of the femur in these parts, and the presence of a less amount of solid lamellated structure, there is usually here less comminution than in gunshot injuries of the shaft. The great vascularity of the trochanteric portion, and the firmness with which the bone is attached to the adjacent tissues, diminish the danger of necrosis and exfoliation. The cases to which we have already referred seem to justify this conclusion. If any surgical operation is demanded in these cases, it is usually exsection.

When the fracture is just below the trochanters; experience having shown that very few recover after these amputations. We think we have seen during the last three years more femurs united after gunshot fractures in the upper third of the shaft, than we have seen successful amputations after the same injuries.

When the fracture of the femur is caused by a pistol ball, by a round musket ball; or by any missile, whose force is nearly spent.

It will be understood that the last observation has reference solely to the less degree of comminution which these missiles usually occasion.

The following conditions must be added as essential to success:

All pieces of bone which are only slightly attached to the soft parts must be removed.

All foreign bodies, such as fragments of balls or other missiles, pieces of cloth, wadding, etc., must be carefully taken away.

Whatever binds or obstructs the external opening and prevents the free escape of blood or of pus, must be divided or removed.

The limb must be placed in a position of absolute rest, and must remain at rest. It must not be confined by tight bandages, or forcibly extended by apparatus.

If the knee-joint is implicated it must be laid freely open and placed at perfect rest, without adhesive straps, bandages, or other means of compression.

During the whole treatment the limb must be handled with great care, and not lifted roughly or carelessly.

When sinuses form, the matter must be let out by direct or counter-openings, and not by violent pushing and thumbing.

When spicula of bone present themselves, they must be removed.

The patient must be supplied with a good, nourishing diet.

Dr. John T. Hodgen, Surgeon of Volunteers, who has been for some years in charge of the City General Hospital,

U.S.A., at St. Louis, has communicated to the author some results of his extensive experience, from which we observe that he has had under treatment seventy-one cases of gunshot fractures of the femur; of this number fifty-two have recovered and nineteen have died; showing a mortality of only a little over twenty-six per cent. It must be noticed, however, that this hospital is remote from the field, and that the wounded were not received until after the lapse of one or two weeks from the period of the receipt of the injury. We have in these statistics, therefore, no testimony as to the number who died after the receipt of their injuries; many, whose broken thighs were not amputated, no doubt died on the way; but we have evidence as to what may be accomplished by skilful management when these accidents are received into well ordered hospitals. This surgeon informs us that he has not made one amputation for a gunshot fracture of the thigh, and that he has seldom interfered with the loose fragments of bone—never, unless the period was favorable, and they were already nearly detached. Amputations were not made because the period was past, or had never arrived, in which it seemed proper to make them. In these remarks Surgeon Hodgen shows himself to be a conscientious, observing, and intelligent surgeon. Certainly no hospital can present a more satisfactory record.

We shall hereafter speak of his peculiar mode of treating these fractures.

The plans which have been devised by American surgeons for supporting, extending, and for rendering more easy the dressing of these limbs are in general original, and have contributed very much, we think, to our success.

If we consider the treatment of the fracture alone, the best results will generally be obtained with the limb resting

upon the bed in a straight position; or only slightly lifted from the bed, still maintaining the straight position, as originally practised by Hodgen, and whose method we shall presently describe. By this practice the fragments can be kept more accurately in line, and in this way we can employ more steady and effective extension.

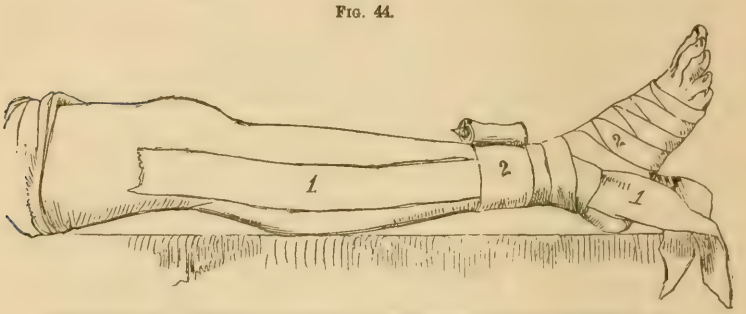
It must be distinctly understood that we do not recommend a long straight splint, with the usual means for extension and counter-extension, in any one of its various forms, unless it be as a very rare exception to the rule. A perinæal band can rarely be borne in gunshot fractures of the thigh, and a long, broad side-splint is always very much in the way of the dressings. The method which we recommend is, laying the limb upon the mattress or some sufficiently firm and even support, on the same, or nearly the same plane, with the body; making the extension by a weight attached to a cord drawn over a pulley, while the counter-extension is made with the weight of the body, by elevating the foot of the bed. This is the plan, more or less modified, which has been adopted in a large proportion of the cases which we have seen under treatment; and, we think, with the best results.

There are only two principal modifications of this straight position generally employed by us; in the first, the limb rests directly upon the bed, and consequently it is not always accessible for the purpose of dressing the wounds: in the second, it is moderately lifted or suspended by a frame and cotton bands. In all other respects the plans are essentially the same.

To speak of the first of these methods a little more in detail: the extension should be moderate and barely sufficient to steady the limb or to prevent the ends of the broken bones from pressing into the flesh; for this purpose

we apply a broad band of adhesive plaster along each side of the leg, from the knee downwards, and secure these in place with a roller, covering certain portions of the limb

Fig. 44.



EXTENSION BY ADHESIVE PLASTERS, AS PRACTISED BY THE INVENTOR, DR. JOSIAH CROSBY.

1, 1, Adhesive plasters. 2, 2, Roller.

with cotton batting before applying the roller, to prevent excoriations; the end of the adhesive plaster should be laid over a small block below the sole of the foot, which block must be of sufficient width to protect the malleoli from the pressure of the bands. A small rope, knotted at one end, is then to be run through a hole in the centre of the block, and carried over a pulley at the foot of the bed. The pulley must be so high that the extension shall lift the heel a very little from the bed. A common spool set in a slot in a narrow piece of board, and made to revolve upon an axis of strong wire, will answer the purpose of a pulley; the board being fastened securely against the foot of the bed. (Fig. 47.)

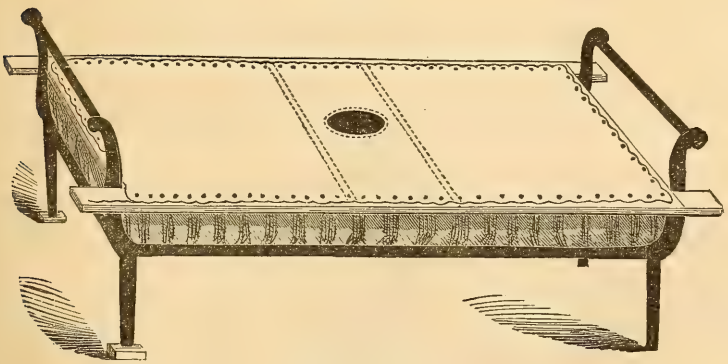
The weight, composed of sand in a bag or in a tin vessel, or of anything else which may be found to be most convenient, ought seldom to exceed five or six pounds at first; the amount to be increased from time to time, as may be necessary or as can be easily borne. We have seen

twenty pounds applied, but ten or fifteen is generally all that is useful. The foot of the bed will have to be elevated, in most cases four or six inches, to make the requisite counter-extension. Some prefer to elevate the mattress only from the hips, by sliding some blankets in the form of a wedge underneath. If a counter-extending band is found to be necessary, it should be placed in the perinæum of the sound limb; if placed in the perinæum of the injured limb it will probably occasion an increase of the congestion and swelling. No side splints can usually be employed until after the lapse of several weeks; but the limb may be sometimes advantageously supported by junks of sand, laid against both sides of the leg and thigh, or by bundles of straw lightly bound to the sides of the leg and knee.

As soon as possible, the surgeon should have constructed a strong frame, a little longer and wider than the mattress

THE AUTHOR'S MODE OF TREATING GUNSHOT FRACTURES OF THE FEMUR.

FIG. 45.



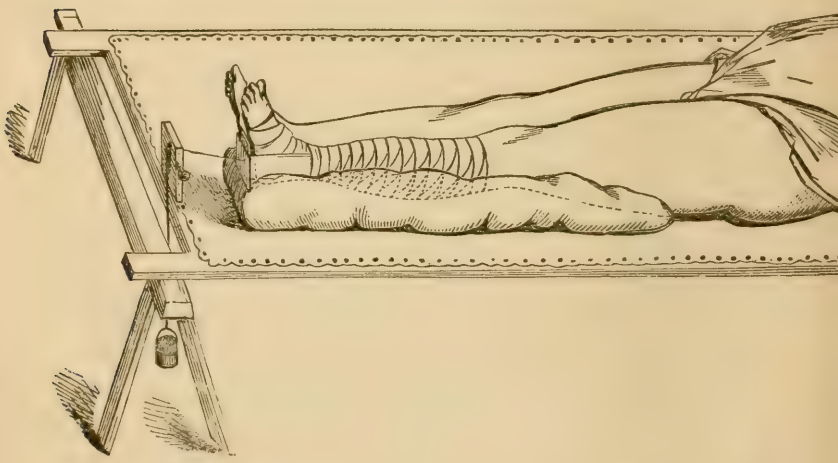
Canvas frame laid upon the bed, and the foot of the bed elevated by bricks.

upon which the patient reposes, covered with firm canvas, which canvas should be reinforced a little above its centre

by a second piece two feet in width, and stretched from one side-rail to the other; through this central portion or a little above the centre of the canvas, a hole should be made one foot in diameter, and firmly bound with tape. (Fig. 45.)

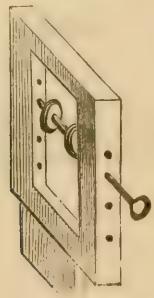
This frame may now have the upright board, which sup-

Fig. 46.



Canvas frame removed from the bed and laid upon "horses."

Fig. 47.



Foot-block and pulley.

ports the pulley, made fast to the bottom rail. If the

rails are of the proper thickness, the upright board will be secured firmly and readily, by inserting it into a broad slot in the bottom rail.

Thus constructed, the frame is placed upon the bed and covered with one sheet folded and laid below the central opening, and a second folded and laid above the opening. Upon these the patient is to repose.

In case he desires to use the bed-pan, the frame is lifted and made to rest upon four movable legs, which may be attached to the under side of the frame; or upon four blocks placed at the four corners of the mattress; or if the side rails are made to project sufficiently at the two extremities, the frame may rest upon a couple of movable stands or "horses." The latter method is adopted by one of the surgeons in charge of the Lincoln General Hospital at Washington, and is found to answer the purpose well; and in a General Hospital it possesses the advantage of enabling the attendant to use the same supports for a large number of patients; the patient can also be moved to any part of the room, or taken out upon the piazza, while the bed is being cleaned and aired, without disturbing the fracture. (Fig. 46.)

In the Lincoln Hospital, this method, with more or less trivial modifications, is adopted in all cases, even where the discharge of matter is very profuse, and, we believe, with the most happy results.

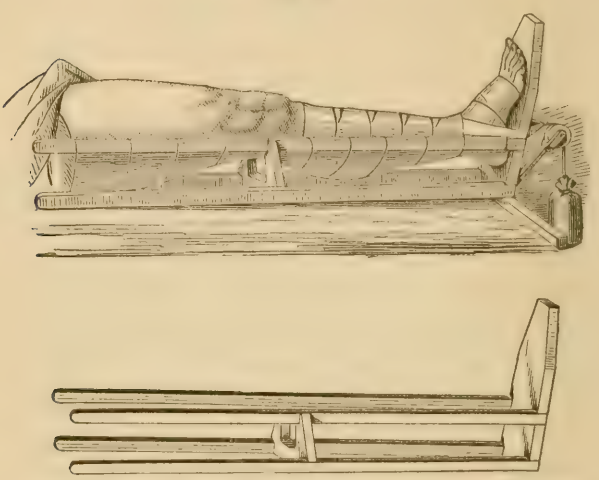
The perinæal band, when it is used, may be fastened to an upright pin placed at a proper point in the side-rail.

One of the advantages of this method not to be overlooked in military practice is, that no apparatus is required which cannot be supplied in a few minutes, and under almost any circumstances.

A very simple and ingenious apparatus, invented by

John T. Hodgen, Surgeon of Vols., maintains the limb also in the straight position; while at the same time it is lifted from the bed and rendered more accessible. (Fig. 48).

Fig. 48.



JOHN T. HODGEN'S CRADLE FOR GUNSHOT FRACTURES OF THE THIGH.

The apparatus is composed of four nearly parallel bars and a foot-board; two of the bars constituting the base, and the remaining two, covered by transverse slips of cloth, being intended to receive and support the limb.

The longitudinal bars are forty-two inches long, and the upper bars are elevated four inches and a half above the lower; the space between them diminishes from the upper to the lower ends, being twelve inches at the groin, eight at the knee, and four at the foot. The foot-board is fourteen inches high, four and a half inches wide, and is supported by a cross-piece or foot underneath, fifteen inches long.

The transverse strips of cloth, each two and a half inches wide, are placed in contact, and adapted to the inequalities of the limb.

Adhesive straps are secured to the sides of the leg by a roller and brought around the foot-piece; a cord, to which is suspended a weight, is made fast to the centre of the foot-piece and passed over a pulley, and this constitutes the extension. The counter-extension is made by lifting the foot of the bed four or six inches.

In adapting one of these splints to any patient, the longitudinal bars being all of the same length, those corresponding to the groin, or inner side, will have to be shortened.*

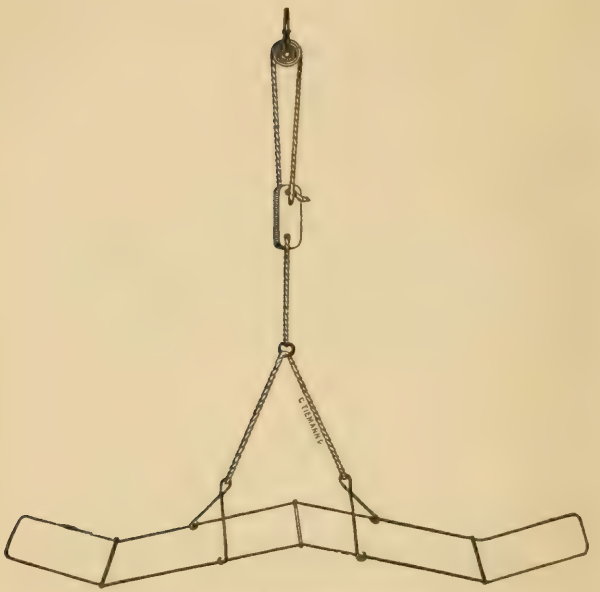
If constructed especially for any particular case, the dimensions will be varied according to the length and size of the limb.

Dr. Nathan R. Smith, of Baltimore, introduced to the notice of the profession some years since a double-inclined plane, made of wire, and intended for suspension. The splint is placed above the limb instead of underneath, and it is known, therefore, as Smith's Anterior Splint. This splint was employed very much during the first two years of the war, and it is still preferred by many army surgeons; but in our opinion it ought, except in a few cases, to give place either to Hodgen's suspension splint, or to one of the two forms of apparatus which we have just described.

Smith's splint is composed of a frame, made of stout wire (size No. 10). Its length should be sufficient to extend from the anterior superior spinous process of the ilium, to a point beyond the toes, the lateral bars being separated about three inches at the upper end, and two inches and three-quarters at the lower end. Before being used it is covered with cotton cloth to protect the limb from immediate contact with the wire. The limb is then secured to the splint by successive turns of a roller from the foot to the groin.

* American Medical Times, May 23, 1863; August 29, 1863.

Fig. 49.



N. B. SMITH'S ANTERIOR SPLINT.

Fig. 50.

N. B. SMITH'S ANTERIOR SPLINT APPLIED.

When this splint is applied to a broken femur, one of the hooks, to which the suspending cords are attached, should be made fast to the splint about opposite the seat of fracture, and the other should be secured a little above the middle of the leg; while the point of attachment in the ceiling, or to the frame from which the suspension is made, should be a little in advance of the knee, and not perpendicularly above it; this will secure a certain amount of extension and counter-extension upon the thigh.

The principal objection to this splint is the difficulty of applying the splint and roller from time to time, without disturbing the limb at the seat of fracture. We have noticed, also, that most of the limbs treated with this apparatus are slightly bent back at the point of union. Moreover, we cannot always employ all the extension which might be useful.

Notwithstanding these objections, the splint possesses a great many points of excellence, and will continue to find many special cases for its application.

In our opinion, John T. Hodgen's Wire Suspension Splint, which the inventor has substituted for his own "cradle" already described, is much superior to Smith's Anterior Splint. It has been placed among the army hospital supplies, and is at the present time in great favor with our army surgeons.

Dr. Hodgen's splint* is also made of iron wire (size No. 2), and resembles in many points Dr. Smith's Anterior Splint, but its mode of application is not the same. Strips of cloth are laid across the splint from side to side, and upon these the limb is laid. The centre and upper extremity of the splint are kept asunder by strong bows of iron wire, so arranged that they can be put on or taken off with-

* Hodgen, St. Louis Medical and Army Surg. Journal. New Series, No. 1.

out disturbing the dressings. When applied, the inside wire must be bent upwards at its upper extremity, so as to

Fig. 51.

DR. HODGEN'S WIRE SUSPENSION SPLINT.

make room for the pubes. Extension is made by adhesive plasters, and the whole apparatus is finally suspended to the ceiling or to some point above by a rope and pulley.

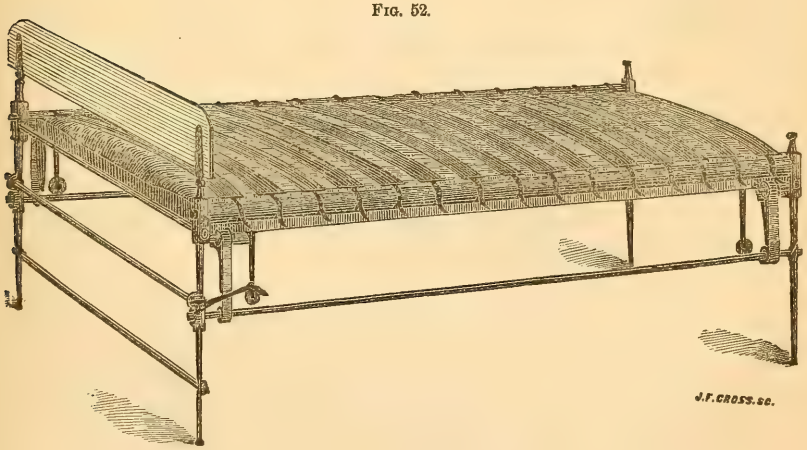
Strong wire frames, covered with canvas and capable of being adapted to limbs of various sizes, and of being placed at various angles, upon which both thigh and leg may be laid, have also been advantageously used in transporting the wounded from the field; indeed they have in some cases constituted the sole support, where other means were not at hand, until the cure has been accom-

plished. They cannot, however, be properly substituted for either of the plans before mentioned.

Very recently Dr. Elisha Harris, of the Sanitary Commission, has introduced into the supplies furnished by this Commission, metallic troughs made of perforated tin, which are found to be light, economical, and easily adapted. We are certain that they will prove of great value, especially as a means of support during transportation.

Dr. Josiah Crosby, of Manchester, N. H., has invented a very ingenious invalid bed, which, upon the recommendation of an Army Medical Board, recently convened in Washington, has been introduced into several of the U.S.

FIG. 52.

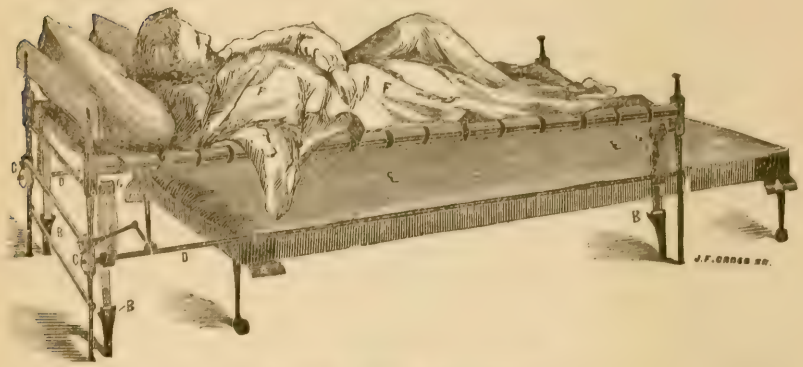


DR. JOSIAH CROSBY'S INVALID BED.

General Hospitals, and has been found to be exceedingly useful in certain cases of gunshot injuries of the lower extremities. It is so constructed as that, while the patient lies suspended upon broad and firm bands, the bed can be lowered, one of the straps loosened, and a bed-pan used; or

the bed may be run out and aired or changed; or the wounds exposed and dressed, while at the same time the

Fig. 53.



DR. JOSIAH CROSBY'S INVALID BED.

patient is himself aired and comforted. With this contrivance, bed-sores are no more liable to occur than if the patient was resting upon a water or air bed. The foot-board and extension by weights may be used as well as in any other form of bed.

LEG.

A gunshot fracture of either the tibia or fibula alone, will not usually demand the use of a splint; the remaining bone, even though it be only the fibula which is left, giving all the support which is necessary.

When both bones are broken completely asunder by a rifle ball, or other large shot, the surgeon will not often find it prudent to attempt to save the limb. In general the comminution is even greater than in fractures of the femur. There is so little covering to the tibia in front that protrusion, especially of the lower end of the upper fragment, is

very prone to occur in the progress of the treatment. The posterior and anterior tibial arteries lie so near the bones that severe primary hæmorrhages frequently result; and from the subsequent displacement of the fragments, secondary hæmorrhages are apt to occur. The depth at which these arteries lie from the surface, also, renders their ligation generally difficult, and always demands extensive dissections.

If an attempt is made to save the limb, loose, floating fragments must be removed, and the limb must be at once placed in the easiest possible position, being sustained by only moderate lateral pressure. Neither extension nor counter-extension can generally be made to any purpose. Possibly, when the fracture is high in the leg, adhesive plasters applied to the sides of the ankle and lower portion of the leg, and secured to a foot-board, may be of some little service in steadying the limb; but as to overcoming in any appreciable degree the tendency to shorten, this cannot be done without endangering the vitality of the parts to which the extension is applied. This statement is the result of observation; but if the inexperienced surgeon requires an explanation, he will find it in the swelling and tenderness about the lower part of the leg and ankle, which so speedily follow these accidents.

It is impossible to lay down any absolute rules as to the position which the limb should occupy. Sometimes the fragments will be found most at rest when the leg is made straight upon the thigh; but in the large majority of cases, the position of moderate flexion will be required; the limb either resting upon its side, as recommended by Pott, or upon its posterior surface as is most generally practised.

The position and character of the wounds will generally determine this point.

Hodgen's Cradle and Suspension Apparatus, which has been described in connexion with fractures of the thigh; Nathan R. Smith's Anterior Splint, and some other forms of the double-inclined plane, may be employed when the limb is to rest upon its back. Whatever form of apparatus is used in this position, the foot will require always the support of a foot-board; care must be taken not to arrest the circulation by pressure under the ham; and the heel must never be permitted alone to sustain the weight of the foot.

A box, suspended from the ceiling, in which the limb rests upon strips of cotton cloth; or a simple frame, open at the sides, covered with strips of cloth, make convenient supports, and render the wounds accessible for the purpose of dressing.

The box containing bran, long since suggested by Barton of Philadelphia, is especially convenient in warm weather, when maggots are apt to infest suppurating wounds. A box constructed for this purpose should be two or three inches longer than the leg, measuring from the middle of the knee; and three inches wider than the diameter of the limb at its widest part, so as to provide for swelling; the sides should be movable, being attached along the base by hinges. To prevent the bran from escaping, a piece of cloth longer than the leg, and about two feet wide, should be laid inside the box, the bran to be poured into the cloth until the box is about one-third full; upon this the limb is to be carefully placed in a straight position, and the free upper extremity of the cloth being pinned snugly around the thigh, just above the knee, the bran must be again poured in on each side of the limb, in contact with the skin, and packed with the fingers. If the wound is covered with lint, previously spread with simple cerate, the bran may envelop the whole surface. Even this protection may be unneces-

sary, as we have never seen the bran occasion any irritation in a wound.

By this method we protect the wound not only from flies, and avoid all danger of being annoyed by maggots, but the matter and blood being absorbed by the bran, does not soil the bed, and does not become offensive. It forms also a firm, uniform, and sufficient lateral and back support to the limb, and is in effect a splint.

These limbs often ooze a good deal of blood during the first two or three days; and whatever other mode of dressing we adopt, we find it necessary to remove everything once or twice during this time, very much to our annoyance, and to the annoyance of the patient. The bran-box obviates all this trouble. It has sometimes happened, also, that the absorption of blood by the bran has increased its bulk so much that, by its lateral pressure, it has closed the bleeding vessels.

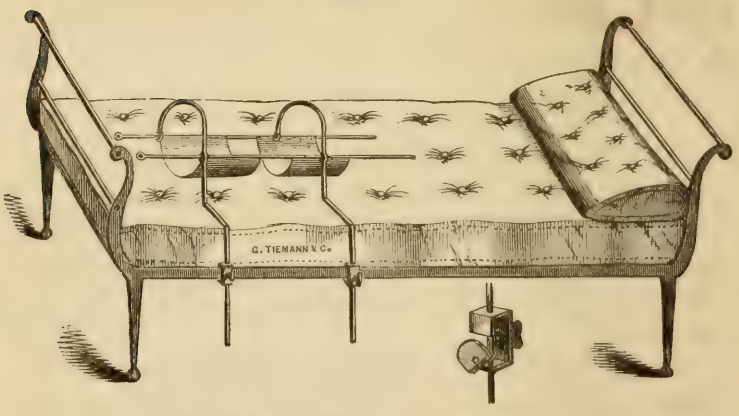
When it is thought necessary to remove any of the bran which is soiled, it can easily be done with a case-knife or with an iron spoon, its place being immediately supplied with fresh bran.

In all cases where a leg is laid in a box, the box ought to be swung clear from the bed. If this is not done, the gradual sliding of the body downwards in the bed while the box remains fixed, will thrust the upper fragments down, painfully irritating the flesh and shortening the limb. It need not be elevated more than one or two inches, which will be sufficient to allow it to float freely. The most perfect arrangement which has ever been devised to obviate this difficulty is "Salter's Cradle," in which the box is suspended upon pulleys which run in an iron groove or rail, so that the box cannot fail to move in the same direction, and to the same extent, with the body.

The box ought not to be allowed to float much, if at all, laterally, since this motion while the thigh is resting upon the bed, necessarily moves the broken ends; especially is this apt to happen if the fracture is high in the leg. Nor should the patient be allowed to rise up and lie down often in bed; the effort to rise always calling into action the extensor muscles on the front of the thigh, and causing the upper fragment to move.

The suspending apparatus invented by George F. Shrady, A. A. Surgeon, U.S.A., and designed to be adjusted to the side of an army bed, is very simple and ingenious. It is composed of two strong iron bars which are fastened by

FIG. 54.

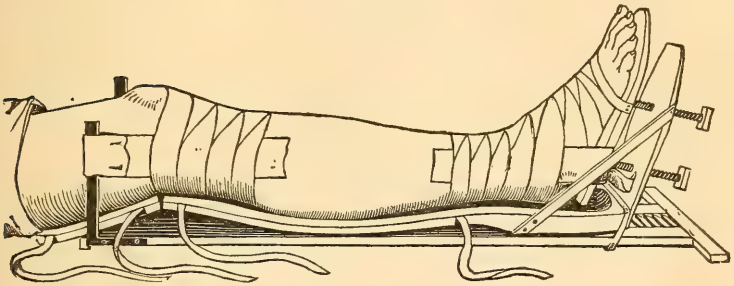


GEORGE F. SHRADY'S SUSPENDING APPARATUS.

clamps to the side of the bed, and which bend over the limb, and support two horizontal bars made of wire. The horizontal bars have laid over them pieces of cloth, upon which the limb is to repose. By the aid of the clamps any degree of elevation may be given to the limb, and it can be placed at any inclination.

Occasionally, when little or no swelling supervenes upon the accident, or after the swelling has in a measure subsided, the broken bones may be kept more completely in line, and rendered steady by employing adhesive straps in the manner shown in the accompanying wood-cut, as suggested by Drs. Crosby, Neil, Crandall, and others.

Fig. 55.



LEG SUPPORTED AND MODERATELY EXTENDED BY ADHESIVE PLASTERS.—CROSBY.

As we have already explained, however, there could be no greater mistake than to adopt this practice indiscriminately, or in any case where much swelling was actually present or was anticipated; or to employ much force in the hope of effecting any material change in the length of the limb.

In the accompanying illustration the cushions, which must be interposed between the splint and the limb, are omitted for the sake of distinctness.

CHAPTER XVIII.

AMPUTATIONS.

SECTION I.—GENERAL OBSERVATIONS.—There are several questions relating to amputations which need to be considered briefly and in their proper order.

First.—*What conditions of the limb in army practice demand amputation?*

Simple fracture of a limb, it is unnecessary to say, does not demand amputation.

A fracture complicated with considerable laceration of the skin, or of the skin and muscular tissue, does not of necessity demand amputation.

A fracture, with laceration of the main arterial trunk supplying the limb, does not necessarily demand amputation. If the artery can be tied the limb may be saved, and the fracture treated successfully.

A fracture, accompanied with the laceration of one or more of the principal nervous trunks, does not always demand amputation, yet it is a graver accident than the one last supposed.

A fracture, complicated with a destruction of both the principal arterial and nervous trunks, occurring in the course of a large limb, like the thigh, the leg, the arm, or the forearm, renders amputation necessary.

Similar lesions, without a fracture, render amputation almost equally imperative.

Comminuted fractures, accompanied with extensive lesions of the soft parts, or with a rupture of either the principal artery or the principal nerves, in the case of large limbs, generally demand amputation in army practice.

Compound fractures, with either of the above complications, in large limbs, generally demand amputation.

Fractures accompanied with extensive and violent contusion, demand amputation oftener than the same fractures accompanied with open laceration.

In army practice, gunshot wounds which penetrate fairly the shoulder-joint, the elbow-joint, or the wrist-joint, demand in most cases either amputation or exsection.

Gunshot wounds penetrating the hip-joint are generally fatal, yet amputation may be practised under some very favorable circumstances. Exsection also presents a feeble ground for hope.

Amputations after gunshot fractures of the upper third of the shaft of the femur are seldom successful.

Primary amputations for gunshot fractures in the middle or lower thirds of the femur, present a much better average of successful results.

Gunshot wounds involving the knee-joint demand amputation in almost all cases. Guthrie has seen no recovery from a gunshot wound of the knee-joint, unless the limb was amputated. We have seen a few recoveries, especially when the joint was penetrated by round balls, or when the joint was only slightly opened.

Gunshot wounds, in which the ball does not actually enter the joint, but in which the bone is struck above or below, and the line of fracture extends into the joint, are subject to nearly the same rules as that class of cases in which the ball enters the joint; but the rule is less imperative.

Gunshot wounds fairly penetrating the ankle-joint or the tarsal bones, demand either amputation or exsection.

Gunshot wounds of the metacarpal or of the metatarsal bones are often cured without amputation. Similar wounds of the fingers or toes do not in general result so favorably; but the rule in this latter case cannot be stated very positively.

Second.—*The point at which the amputation is to be made.*

This must depend mostly upon the part of the limb which has suffered injury; but in general we may say, at as low a point as will be safe; or in other words, we would state the rule to be, to *save as much of the limb as possible.* Yet in no case should the life be put at hazard for the sake of a limb, much less for a small portion of a limb.

There are two reasons why we adopt the rule above stated. First, because the longer the stump, the more useful it will be to the possessor; and Second, because experience has shown that the nearer an amputation is made to the trunk and the larger the circumference of the limb, the greater is the danger to life. Thus, according to Malgaigne, only 1 death occurred from 26 amputations of one of the smaller toes; 7 deaths from 46 amputations of the great toe; 9 from 38 partial amputations of the foot; 106 from 192 amputations of the leg; and 126 from 201 amputations of the thigh. Again, in the Crimea the mortality after amputations of the thigh, in a certain number of cases, was as follows: Lower third, 56 per cent.; middle third, 60 per cent.; upper third, 86 per cent.; hip, 100 per cent. (23 cases).

Stephen Smith, in a paper on hip-joint amputations, has brought together 98 cases, obtained partly from military and partly from civil practice, of which 56 proved fatal; a ratio of mortality of only 57½ per cent. In the Mexican

campaign all amputations at the hip-joint terminated fatally. In a total of 44 cases of amputations for gunshot injuries, collected by Legouest, 40 died. The four which recovered were secondary amputations.

During the present war two successful amputations have been made at the hip-joint. One by Edward Shippen, Surgeon, U.S.V., and one by Dr. E. S. Fenner, of the Confederate Army.

We have heard of three unsuccessful operations. How many more may have been made we are unable to say.

The mortality after amputation of the femur through the upper third, is stated to have been in the Crimea, eighty-six per cent., but it is quite probable that it was much higher. McLeod says that he never saw himself any case recover in which the amputation was beyond doubt in the upper third. The French and Russians also found these amputations so hopeless that they almost abandoned them.

The same law of relative mortality has been observed by the British surgeons in amputations of the upper extremities. After amputation of the forearm, seven per cent. died; of the upper arm, nineteen; and of the shoulder-joint, thirty-five per cent.

The experience of our own surgeons confirms these observations.

In certain instances, however, we find it convenient or necessary to deviate from the rule which we have established to "save as much of the limb as possible."

There is no reason to suppose that disarticulations, or amputations made through joints, are any more dangerous than amputations made by section of the bone; and on the field, time is of so much consequence, that we can well afford to sacrifice a small portion of a phalanx, by disarticulation at the nearest sound joint, rather than make the

delay necessary for the application of the saw. Nor is it scarcely worth while to attempt to save a few of the carpal bones, when the disarticulation can be effected at the wrist-joint so much more speedily and neatly; indeed, if they were saved, they would, under any circumstances, add little or nothing to the value of the limb.

Other things being equal, we might prefer to amputate just below the elbow-joint, rather than through the joint, in order to save an inch or two of the radius and ulna; but the dangers to the patient are not, we think, precisely equal. It is safer to amputate through the joint than at a point in such close proximity below, since by the latter method we expose the patient to the danger of inflammation extending from the wound upwards into the unopened, but more or less disturbed articulation. The same remarks apply to amputations made an inch below the head of the humerus. It will be safer, generally, to disarticulate at the shoulder-joint; but disarticulation flattens the shoulder, and does not leave so handsome a stump. This latter operation was made in the Crimea, from the first of April to the end of the war, one hundred and two times, and it was followed by death in only twenty-five cases.

We would, upon the field or in civil practice, amputate toes only at the articulations; occasionally we may make an exception in favor of the first phalanx of the great toe, which can with advantage sometimes be divided through its middle portion.

In amputating at the foot, we may remove all the metatarsal bones, according to the method recommended by Heys; or we may separate the tarsal bones between the calcaneum and astragalus on the one hand, and the cuboides and scaphoides on the other, as practised by Chopart; a portion only of the calcaneum may be saved, as in the ope-

ration of Pirogoff, or the complete disarticulation may be effected at the ankle-joint, as recommended by Syme.

We would not amputate within an inch of the knee-joint, for the same reason that has been given for preferring not to amputate just below the elbow-joint. It has been found to be extra-hazardous.

Amputation through the knee-joint is not particularly objectionable. Baudens says that his experience in the Crimea enables him to affirm that disarticulation of the knee ought always to be preferred to amputation of the thigh. Of eighty-six cases brought together in the Nov. No. 1852, of the *N. Y. Jour. Med.*, by Prof. Stephen Smith, forty-nine resulted in recovery, and thirty-seven died, giving forty-three per cent. as the ratio of mortality.

Dr. David P. Smith, U.S.V., reports eight cases in the No. of the *N. Y. Med. Times*, for March 7, 1863; in all of which cases, except one, he thinks the patients recovered. In the fatal case, the man died within twenty-four hours after the operation, "apparently from the fact that the surgeon who administered the chloroform gave a very large quantity." We have ourselves operated many times on the field at this point, and without being able to state the results precisely, we have reasons to believe that the operation has been more successful than amputation either immediately below or above the joint. In only a few examples have we seen a troublesome secretion from the synovial surface. In one case only has this source of annoyance persisted after the lapse of several months. Of the relative safety of this operation we have no doubt; and we are informed by Dr. Hudson, the artificial limb-maker, that it furnishes a better stump for his purposes than a section of the shaft just above the condyles.

Amputations made through the cancellous structures, near

the ends of long bones, are less dangerous than those made through the shafts. This is explained by the fact that amputations through the tubular portions of the bone expose to diffuse inflammation and suppuration of the medullary canal.

Third.—*The method of amputation.*

Upon this point surgeons remain greatly divided. Velpeau, Guthrie, Tavernier, Sir Astley Cooper, Ben. Bell, Charles Bell, Gibson of Philadelphia, Paul F. Eve of Tennessee, and many other distinguished surgeons at home and abroad, prefer the circular method. In France this mode is generally practised.

Liston, Lizars, Fergusson, and Syme, who may be said to represent the Edinburgh school, prefer the flap method. In this country it has been very generally adopted, especially by the younger class of surgeons.

Without entering into a discussion of the relative advantages of these two methods in *general* practice, or attempting to reconcile the conflicting opinions of the two parties, we shall content ourselves by affirming our belief that both methods have their special applications; and that, in general, the choice may be safely left to the judgment of any intelligent surgeon.

In relation to their application to *military* practice, however, it seems necessary to make one or two special explanations.

In nearly all amputations made upon the field, where haste is demanded, flap amputations have the advantage. They can be made in less time, and where time is a consideration of the greatest moment, they are to be preferred.

If, however, time is of less importance, as it will be whenever the number of surgeons is properly proportioned to the number of wounded, and the patient is to be transported immediately or soon after the operation a long dis-

tance, preference ought to be given to the circular amputation, at least in the case of all large limbs.

The heavy flaps attached to the end of the limb, disturbed by incessant motion, loosen, and become gangrenous or ulcerate. This was the experience of the Crimean surgeons, where soldiers were transported long distances by land after amputation; and even when carried upon transports to Scutari, the same fact was observed.

Our own military surgeons are about equally divided in their preferences; but we have many times had occasion to notice after severe battles, the greater frequency of sloughing and of secondary hæmorrhages, in limbs amputated by the flap methods—especially when large masses of muscle have been included in the flaps—than in limbs amputated by the circular methods, and when the coverings were composed entirely of skin, or of skin with only the superficial muscles, as is recommended by Guthrie.

But whatever method of amputation is adopted, there is one thing upon which we desire to insist, as of paramount importance—namely, that the bone should be well dissected up before it is severed. The length of flap is always of less consequence than the depth at which the section of the bone is made underneath the mass of flesh. In order to accomplish this, it is our practice to apply the retractor firmly, girdle the bone closely with the knife, and then with the thumb-nails or the handle of the knife, peel up the periosteum freely an inch or more. In addition to the value of this practice in the point of view already considered, it is possible that it may be of service by retaining a sort of periosteal flap or covering for the end of the bone.

Fourth.—*The period of time at which the amputation ought to be made.*

"Immediate" amputations, as the name implies, are those which are made immediately or within a very short time after the receipt of the injury. The term cannot with propriety be applied to amputations made after the lapse of ten or twelve hours.

"Primary" amputations, in the meaning of the term as now employed by most surgeons, are amputations made during the first twelve, twenty-four, or thirty-six hours; but not until after the severity of the shock has passed off, and more or less complete reaction has taken place in the general system. When writers speak of "primary" amputations, therefore, they intend generally to exclude from consideration "immediate" amputations. This distinction has not always been observed, but it is essential to a correct understanding of the subject.

"Secondary" amputations are those made after the inflammation consequent upon the injury has in some measure, if not altogether subsided—when perhaps suppuration has commenced, or even at a much later day.

It will be observed, therefore, that there is usually a period intervening between the primary and secondary periods—the period of congestion or of inflammation; and which, for the reason probably that it has never been regarded as suitable for operations, has not always been specifically named; this is called the "intermediate" period.

We will first consider the value of immediate as compared with primary amputations.

The "shock" is that condition of the nervous system which immediately ensues upon certain injuries in certain persons, characterized especially by coldness of the surface, pallor, and a feeble pulse; to these conditions are sometimes added tremors, a wild, anxious expression of the

face, sighing respiration, partial or complete paralysis of the bladder and sometimes of other organs, mental disquiet or apprehension, incoherent speech, etc.; which phenomena may continue a longer or shorter period; but usually, unless the shock is severe, they disappear in a few hours. When the accident is of a more grave character, no reaction occurs, and the patient dies immediately, or within a short time. In general it may be said, that if reaction does not occur within twenty-four or at most forty-eight hours, the patient will die.

In some cases the occurrence of the shock seems to be delayed, the depressing influence of the injury not being felt until some little time after. Such, at least, is the opinion of Mr. McLeod, who affirms that he knows of several well authenticated cases which prove the correctness of this position. For ourselves, we confess that we have never met with these examples, except where some visceral lesion or the rupture of a large bloodvessel has accompanied the accident. It is true that men often faint after a few minutes, or after removal, and when they have had time to contemplate their situation, who seemed undisturbed at first; and in other cases a severe and prolonged irritation from a point of bone has steadily aggravated the signs of depression and of shock; but we think these cannot with propriety be termed examples of delayed shock. We do not intend, however, to deny that the nervous agitations may be delayed in some cases, but only to express our conviction that the condition to which our attention has been called by these gentlemen is a rare phenomenon.

Surgeons who hold to the frequent occurrence of delayed shock, recognise in this an argument in favor of *immediate* amputation, in a great majority of cases; and certainly, assuming the premises to be correct, the argument seems

not unsound. Says McLeod, "if this precious moment could be seized at all times, and that operation performed under chloroform, which assists so much in warding off the 'ebranlement' we fear, how much more successful would our results prove, than under other circumstances they can ever be."

The idea of immediate amputation did not, however, originate with those who maintain that the shock may be, and is, in fact, often delayed. Ambrose Paré urged that amputation should be made while the wounded were in sight of the battle-field; and Richard Wiseman, Sergeant Surgeon to Charles the Second, says, "if you decide to operate, do so at once, while the soldier is in heat and in mettle."

Larrey, indeed, seemed to regard amputation as the proper remedy for this peculiar condition of the nervous system. "I have lost," said he, "a great number of soldiers, because, although operated upon within the first twenty-four hours, yet the operations had been made too late.* * * It is then demonstrated that the commotion, far from being a contra-indication to primitive amputation, ought to decide the surgeon in its favor. * * * The effects of the commotion, far from being aggravated, diminish and disappear insensibly after the operation."

Duboy, who served in America during the War of the Revolution, states, that "American surgeons amputated at once, and lost but few, but that the French delayed and lost many."

In regard to this question, it is our opinion, also, that amputations may be made in some cases immediately, or as soon as possible after the receipt of the injury; as, for example, when a limb is nearly torn off, and a dangerous hæmorrhage, which cannot be arrested, is occurring; or when spicula of bone, such as neither the forceps nor fin-

gers can extricate, are causing intense suffering. In all cases of injuries to small limbs, such as the fingers and toes, immediate amputation is proper; and in a considerable number of cases of injuries to larger limbs, when it is clearly seen that the patient is not faint, or depressed, or suffering under great nervous agitation. But we cannot accept of the doctrines of Paré, Wiseman, Larrey, McLeod, and others, without liberal qualifications, and a careful specification of the cases to which their rules are to be made applicable.

It may be that, as Hutcheson declares, the condition which we term shock, is not so frequently present as has been generally supposed, even after severe injuries; or that, as McLeod maintains, there is generally an interval, longer or shorter, between the receipt of the injury and the accession of the nervous commotion. These points may be safely left open for future inquiry; but upon one thing we must insist, namely, that when the nervous agitation or depression is actually present in any considerable degree, amputation of a large limb is generally a most dangerous resource. Amputation may then be necessary for the reasons which we have stated, and perhaps for other reasons which we have not noticed, but the necessity is greatly to be deprecated.

Our own experience has been, after at least twenty years of observation in hospital practice, and after a pretty large experience upon the field, that amputations of large limbs, made after severe injuries and before reaction has fairly been established, have in most cases resulted speedily in the death of the patients.

The cases in which the nervous commotion is "diminished" by an operation, with all deference to the opinion of the distinguished Larrey, we must explain to be those

in which the broken bones, fragments of shell, splinters, clothing, or some other foreign substance lying in the track of the wound, are causing pain and perpetuating the irritation. Sometimes, perhaps, it may be the condition of the nerves themselves, or of the other tissues which have suffered laceration, and the clean removal of which by the knife may occasion relief; but such cases would be recognised by the presence of great pain and extraordinary sensibility in the parts, which must lead us at once and naturally to regard amputation as the proper remedy.

In these opinions we think also we are sustained by the observation of a large majority of all practical surgeons, whether in or out of the army.

Our first duty, then, to many who have fallen upon the field and who cannot escape amputation, is to comfort and sustain them by words of encouragement, and by the administration of water, wine, brandy, or food; and having dressed the wounds temporarily, to wait patiently the establishment of complete reaction before proceeding to the operation.

As to the value of some delay in certain cases, nothing could be more pertinent than the following communication, which the author has received in reply to certain inquiries, from Usher Parsons, of Providence, R. I., surgeon in the United States Navy during the war of 1812. Portions of the letter do not relate especially to the subject of amputation; but it is all of sufficient interest to require of us no apology for its introduction, unabridged, at this place:—

"Dear Sir:—In the battle of Lake Erie, on the 10th of September, 1813, nearly a hundred were wounded; sixty-one of them on board the Lawrence, twenty-three on board the Niagara and about a dozen in the smaller ves-

sels. There were eleven cases of compound fracture, besides simple fractures, many gunshot wounds, and extensive lacerations, and among them all, several amputations were required. Those wounded on board the Lawrence, were ranged on the upper deck, in the spaces usually occupied by cannon and gun-carriages, which were removed from both sides of the deck, to afford room for mattresses. The only shelter over the wounded thus lodged, was an awning that served to screen them from the sun, and tarpaulins and canvas to spread over and shelter them when it rained.

"To the wounded of the Lawrence were added, after two days, those of the Niagara and of the other small vessels. The whole number of patients requiring a recumbent posture on the deck was about fifty. They remained in the ship fourteen days after the action, and were then landed at Erie, and lodged in a large unfinished courthouse, and remained there until cured. Of this ninety-six wounded, only three died, and these were cases of so severe a nature that a surgical operation was not deemed justifiable, and they were left to linger out a few days of miserable existence. This entire success I have ever felt warranted in ascribing to the purity of the air, more than to any other cause.

"Another cause of success worthy of special notice was, the delay of amputations and all severe surgical operations until the system was entirely recovered from the shock of the injury.

"Having sole charge of the wounded of the whole fleet, the other two medical officers being ill, and the wounded being passed down to me faster than I could attend to them in a proper manner, I aimed only to save life during the action, by tying arteries or applying tourniquets to prevent

fatal hæmorrhage, and sometimes applying splints as a temporary support to shattered limbs, and in two or three instances small portions of flesh were divided, which held a dangling limb to the great annoyance of the patient. In this state the patients remained until the following morning, under the free use of cordials and anodynes. At sunrise I commenced amputations, and in the course of the whole day and evening was able to finish all operations and dressings, and I believe do justice to each. On the following day I visited the other vessels, and brought all their wounded on board the Lawrence, and treated them in like manner. Now, as all but the three hopeless cases recovered, it was proved beyond a doubt, that the delay of amputations and other severe operations for one, and some even two days, had no unfavorable effect upon the chances of recovery, and probably some lives were saved by it, which would have been lost had the operations taken place on the day of the injury. I am, however, advancing no new doctrine in this matter, but only adding new facts strikingly illustrative and confirmative of the correctness of those generally received at this day.

"A third cause of success in this action was, the plentiful supply of fresh provisions and vegetables brought to the fleet from the shores of the Ohio, and of a generous supply of wine and cordials.

"Fourthly.—There can be no doubt that cheerful and buoyant spirits, occasioned by victory, contributed not a little to recovery.

"In two other actions I saw much to confirm the foregoing opinions. In an attack on Mackinac the following year by Col. Croghan's small army, transported thither in our vessels, the number wounded was less than that on Lake Erie. Our vessels were crowded and afforded no suit-

able lodgings for the patients—the air became foul—diet was salt meat and dry biscuit, with no fresh vegetables, and added to this, was the failure of our enterprise, we being repulsed. Consequently the wounds acted unkindly, and some died, that under favorable circumstances might have been saved.

"In a third action opposite Black Rock, near Buffalo, nearly a hundred of our sailors crossed the Niagara in a cold November night to take a battery by storm, preparatory to the crossing of General Smyth's army to take Upper Canada. The sailors succeeded, with the loss of seven killed and about thirty wounded. The distance is about one mile across the river, and the wounded were much chilled in recrossing in open boats. The apartments for receiving them were very small and ill ventilated, but this was slightly remedied by a wood fire, which served to establish a current of fresh air from without. There were extensive suppurations, and some deaths of persons who, in favorable circumstances, might have recovered.

"You inquire the result of my experience in amputation for *tetanus*. I think unfavorably of it. I have amputated twice without any benefit. The disease has extended to the spinal cord. Actual cautery over this with an iron brought to a white heat is reported to have saved life in some cases, but I have seen no case of a cure, by any treatment, of an established *tetanus*. For prevention of traumatic tetanus after a battle, I deem it of great importance to graduate the covering and clothing of the wounded, according to the temperature of the air. Hot days succeeded by cold nights are among the prominent causes of tetanus in armies and in ships of war.

"Yours very respectfully,

"USHER PARSONS."

It is seldom that a surgeon operating upon the field can follow the results of his operations; but on the 10th of May, 1861, we were required to make three amputations of the thigh and two of the leg, upon men who had been wounded from sixteen to twenty-four hours, in the battle of West Point, Va. These men were sent, under the charge of one medical officer, to Washington, on the following day; and he has informed us that all of the men made a complete recovery. We heard from three of them directly, and we have no reason to doubt but that the statement of the surgeon in attendance was correct.

It seems necessary to call attention to certain statements which have recently appeared in our own medical journals upon this subject.

We believe that we are correct in saying that all American surgeons prefer primary to secondary amputations; but there are some who advocate strongly immediate amputations: but either they have not always made the proper distinction between these two periods, or they have not been sufficiently careful in their selection of cases to illustrate their views.

Dr. Clark, Surgeon to the 8th Mo. Cavalry, declares that amputations ought to be made "immediately, before reaction is established,"* and he proceeds to show that the results will be more favorable than "after the secondary operation;" of this we entertain no doubt. If we were asked to choose between immediate and secondary amputations, as a rule, we would prefer the former. But the real question at issue is between immediate and primary operations. The same writer subsequently calls his early operations primary amputations, and says that his six cases of "primary amputations" of the leg all recovered, and that of three primary

* Chicago Med. Jour., June, 1863.

amputations of the femur, two recovered; while on the other hand, four of the five secondary amputations of the leg, made "some weeks after the date of the injury, terminated fatally;" and of the three secondary amputations of the thigh, none recovered.

These cases are the result of Dr. Clark's observations at Pea Ridge. The battles occurred on the 6th, 7th, and 8th of March, 1862; and from his statements of the circumstances under which he was placed, we infer that very few, if any, of these amputations were made immediately, but only at the earliest period practicable.

His next experience was at Prairie Grove on the 7th of December, 1862, and is a little more pertinent, since it is distinctly stated that of two amputations made at the middle of the thigh, "immediately after the wounds were received, before reaction was established," both recovered; and three amputations of the leg just below the knee, made under the same circumstances, terminated successfully. All of these were made at the Field Hospital of which he had charge—of course some distance in the rear; and we would have been better satisfied if we had been informed about how many hours had elapsed in each case.

The essential defect of the report, however, is again in the comparison which he institutes between these immediate and the secondary operations which were made "after suppuration was established;" of 12 secondary amputations of the thigh, 11 terminated fatally; and of 8 secondary amputations of the leg, 6 terminated fatally.

Dr. Fisher, of Sing-Sing, in his excellent report of 57 amputations made after the battle of Antietam, on the seventeenth of September, 1862,* states that 25 were made on the same day, and most of them at night; of these only one had

* Fisher, Amer. Med. Times, Jan. 1863.

proved fatal on the sixteenth day, at which time his observation of the cases terminated; 24 were made on the second day, 3 of which were fatal; 4 were made on the third day, and two were fatal; of 4 made from the fourth to the thirteenth day, only one promised a recovery.

These cases illustrate the advantage of primary over intermediary and secondary operations, but do not at all affect the question of immediate amputations.

Dr. Lidell, Surgeon, U.S.V., in charge of Stanton Hospital, Washington, who has written an admirable paper on "Major Amputations for Injuries,"* has rendered it quite probable, from his own investigations, that even in civil practice primary amputations are to be preferred to secondary. He favors, however, immediate amputation, and believes that the occurrence of the shock is generally delayed; yet he makes this judicious qualification: "but if the shock be excessive, or even severe, then it is better to delay the operation until reaction has been fully established."

Dr. Lidell states that at the Stanton Hospital there have been treated under his direction 61 cases of primary amputations, of which 18 died, giving as a ratio of mortality, 29.5 per cent.; 18 of these were of the thigh, of whom 10 died. At the same hospital 12 secondary amputations have been made, of which 6 proved fatal; 7 of these were of the thigh, with 3 deaths.

Dr. J. H. Thompson, U.S.A., reports 12 cases of immediate amputation after the battle of Newbern, N. C., of whom 11 were doing well on the thirteenth day. Before operating, however, in each case, one or two ounces of whiskey were given;† from which circumstance it must be inferred that the operators did not regard the condition of

* Lidell. Ibid. April, 1864.

† Thompson, Amer. Med. Times, July 5, 1862.

prostration as being in itself a reason for preferring this period for the amputation. Dr. Thompson is a surgeon of great intelligence, and a very accurate observer; and his arguments, based upon the results in these twelve cases, must be admitted to possess a good deal of weight, but we have not found it sufficient to disturb our previous well established convictions, and which are the results of observation in a very much larger number of cases.

The danger of amputating in what we have termed the intermediate period, can scarcely be over-estimated. This period is marked by two conditions.

The first, and that which is most generally understood by surgeons, is a well defined condition of inflammation, with the consequent swelling of the limb; commencing at variable points of time after the receipt of the injury, and progressing with unequal rapidity in different cases; but it is seldom well declared within the first twenty-four hours, and it is rarely delayed much beyond forty-eight hours.

The second condition has not been so often noticed by surgical writers. It consists in a serous, with perhaps more or less bloody infiltration of the tissues, unaccompanied with marked signs of inflammation, and not attended with much general reaction in the system. We have found this condition present on the second and third day, about as often as the condition first named, and we have constantly observed that death results even more certainly after amputation under these circumstances than when the limb is actually inflamed.

The period, therefore, for primary amputations is restrained within narrow limits; and we repeat that if, for any reason, the amputation must be either made immediately while the patient is still laboring under the shock, or of necessity be deferred until the accession of the interme-

diate period, it will be far better to operate at once; and we are sufficiently well acquainted with field practice to know that this alternative is often presented to the surgeon. We will say farther, that if surgeons cannot be made to comprehend the danger of delay until congestions and inflammations have ensued, they had better be instructed at once to make all their amputations on the field and at the earliest possible moment; and in every case of doubt the surgeon should be advised to lean to the amputation as to the side of hope. More lives have been lost from attempts to save limbs, especially in the case of the lower extremities, than from amputations unnecessarily made or made too early.

The next question to be determined is, as to the relative safety of amputations made after reaction has ensued, and prior to the occurrence of congestion or of inflammation, on the one hand, and amputations made after the inflammation has subsided, on the other hand.

In *civil* practice, secondary amputations have been claimed to be more successful than primary; but the observations of Lidell have rendered even this doubtful; with us the only point of interest is, what has been the result of experience upon this point in *army* and *naval* practice; and we shall presently see that here surgeons have differed pretty widely, but that at the present moment the great weight of authority preponderates upon the side of primary amputations. In fact, if we would look for advocates of secondary amputations in military practice, we shall have to seek for them mainly among army surgeons of the last, or in the early part of the present century. Faure, who was at the battle of Fontenoy, says, "Amputate after the subsidence of the first symptoms, and when suppuration is produced." John Hunter adopted

the same views. Baron Percy, in 1792, taught a similar doctrine; and in our own century, Blandin and Mann have arrayed themselves upon the same side: while Petit, Le Dran, Bromfield, Boucher, Guthrie, Hennen, Roux, Rush, Armand, McLeod, Guthrie, and a host of others, have decided in favor of primary amputations.

Dr. John L. Stone, surgeon to the Bellevue Hospital, New York, in the November No. for 1849 of the *New York Journal of Medicine*, has given the most complete statistical record of the results of primary and secondary amputations which we have seen; and he sums up his conclusions, in part, as follows:

Primary amputations of the upper extremities are to be preferred both in military and civil practice, being more successful than secondary in both.

Primary amputations of the lower extremities are twice as successful as secondary in military practice.

There is another view of this important question which needs to be stated, and for the presentation of which, in a reliable and statistical form, we are also indebted to Dr. Stone. We refer to a comparison of the results of both primary and secondary amputations, with no amputations at all!

We believe that, after Bilquer, Malgaigne was the first to make the startling announcement that in the attempt to save the limbs, we run no greater risk than we do in amputating them; his opinions being founded upon his experience in the campaign in Poland, "where, in an army of 80,000 men, neither he nor his colleagues succeeded in saving a case after amputation of the lower extremities;" and also upon certain results furnished by the statistics of the Parisian hospitals, where, during a period of three years, the mortality was seventy-five per cent.

It is well known that after the "Astor House Riot" in the city of New York, all of those whose limbs were amputated died. The amputations were primary. While, according to the statements published by Dr. George D. Gibbs, of the wounded in the Parisian hospitals after the revolution of June, 1848, only six deaths occurred in compound fractures of the thigh out of the twelve cases in which an attempt was made to save the limb. These were all gunshot wounds; but it must not be forgotten that so far as the management of the patients was concerned, subsequent to their injuries, they were in the conditions of civil practice.

M. Baudens, surgeon of Val de Grace, and late Army Surgeon in Algiers, and Drs. Walker and Pierson, of Massachusetts, have also done much towards arresting the indiscriminate sacrifice of limbs after complicated fractures. We are not, however, at present prepared to decide all the points in this delicate question, especially as applied to Army Surgery; and while we may hope that the facts brought together with so much care by Dr. Stone may save some limbs, and perhaps lives, by judicious treatment, and without resort to amputation, we may be permitted to express a hope, also, that it will not lead surgeons to indecision and fatal delays, especially upon the field. Certainly we are in no danger of adopting the extreme views of Bilguer and Malgaigne, by rejecting amputations altogether.

In army practice, just here is one of the great points of difference as compared with civil practice; in the former, patients have to be moved often, and to great distances, which render quiet to the limb, and many other hygienic attentions, actually impossible; yet it is upon these alone that the surgeon can rely to save mutilated members. Moreover, it is a matter of great importance for the safety

of other patients crowded into the same wards, that suppuration and animal decomposition shall be prevented as far as this can be done. A military ward, filled with suppurating and sloughing wounds, would soon become untenantable by the generation of poisonous gases. In these circumstances, almost peculiar to military practice, we see some good reasons why primary amputations are likely to prove more successful, and why army surgeons have so generally conceded to them the preference.

SECTION II.—SPECIAL AMPUTATIONS.—In the remarks which we are about to make it is proposed to limit ourselves rigidly to practical observations, and to speak only of those matters in relation to amputations of which the surgeons need most often to be reminded.

AMPUTATIONS OF UPPER EXTREMITIES.

FINGERS.

The metacarpal bones are united to the first phalanges by enarthrosis—ball and socket; the second and third phalangeal articulations are ginglymoid—hinge-like. In the case of each articulation it happens that when the joint is flexed the distal end of the proximal bone is exposed; the proximal end of the distal bone alone having changed its position. They are all supported by strong lateral and anterior ligaments. The extensor tendons supply the place of posterior ligaments.

The flexor sublimis is attached to the two sides of the middle phalanx; the flexor profundus to the proximal extremity of the third phalanx, and to the sides of the first phalanx by a thin fibrous bridle.

The synovial membranes which cover the flexor tendons of the index, large, and ring fingers, terminate usually in

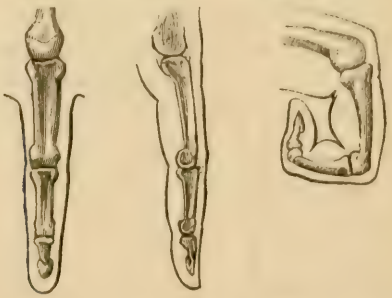
a *cul-de-sac*, opposite the metacarpo-phalangeal articulations; but it is not so with the thumb and little fingers; consequently, inflammation and purulent infiltrations are more apt to extend into the palm of the hand in case of amputations of the latter than of the former.

The phalangeal or collateral arteries are small, and lie upon each side of the phalanges. They do not generally require a ligature, the hæmorrhage ceasing as soon as the flaps are closed and the bandage is applied.

The metacarpo-phalangeal articulation will be found, when the fingers are straight, on the dorsal surface, at the summit of the interdigital commissure, corresponding to the most prominent point of the knuckle; on the palmar surface, in the adult, about one inch towards the body from the free margin of the interdigital commissure.

The transverse and crescenting folds of skin which mark the position of the several articulations, are usually lost in cases demanding amputation, and possess not much value, therefore, as guides. The transverse folds correspond in

Fig. 56. Fig. 57. Fig. 58.



general to the articulation when the fingers are straight; but when they are flexed the joints are found, on an average, half an inch forward, or nearer the ends of the fingers. It is of more importance to know that, when the

joints are flexed to a right angle, the articulation is, upon the dorsal surface, about half an inch beyond the greatest prominence of the joint.

In amputating the fingers in their continuity it is of little consequence whether the circular or flap methods be chosen. If the flap method is adopted, the principal flap should be taken from the palmar surface, since this surface contains the most fibro-cellular tissue, and this mode of making the flaps removes the cicatrix from pressure in the subsequent use of the fingers. The bone may be severed by a fine saw, or by the bone-cutters.

Amputations of the two last phalanges through their contiguity—*i.e.*, through the joint surfaces—ought to be made by the circular method, since the flap method does not so well protect the expanded ends of the bones.

Amputations of one finger or of the thumb, at the meta-carpo-phalangeal articulation, should be made with two lateral flaps. (Fig. 59.) The surgeon should here bear

Fig. 59.

in mind the great expansion of the proximal ends of the first phalanges.

Amputations of all the fingers at the same time, or of two

or more adjacent fingers, at the metacarpo-phalangeal articulation, should be made with palmar and dorsal flaps; the palmar flap commencing at the interdigital commissure, and being the largest of the two. Both flaps are more neatly and more rapidly made by cutting from the surface towards the bone with a common bistoury, than by any other method.

METACARPAL BONES.

The removal of single metacarpal bones should always be effected, if possible, by a process of exsection. That is, the bone should be removed through a dorsal incision, avoiding, whenever it can be done, a section of the palmar surface of the hand. Fig. 60 illustrates this mode of removing the metacarpal bone of the thumb.

Fig. 60.

Fig. 61 represents the same procedure applied to the metacarpal bone of the index finger.

If it becomes necessary to remove the metacarpal bones of the ring or large finger, they must be approached also from the dorsal surface; and sometimes it will be found

convenient to sever the bone through its centre, either with the bone-cutter or the chain-saw, before attempting to disarticulate.

Fig. 61.

When all the metacarpal bones are to be disarticulated together, a dorsal and a palmar flap should be made.

Fig. 62.

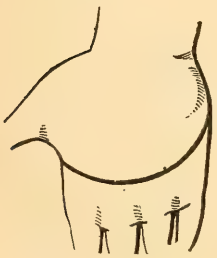


Fig. 63.

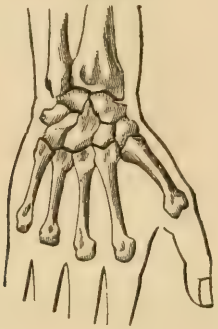
The principal flap should be made from the palmar surface. It sometimes happens that we are compelled to remove all the metacarpal bones except that of the thumb. The thumb, if saved, may be of great value.

CARPUS.

The carpal bones are arranged in two rows. Those of

the first row, commencing from the radial side, are the scaphoid, semilunar, cuneiform, and pisiform; those of the second row are the trapezium, trapezoid, magnum, and unciform.

Fig. 64.



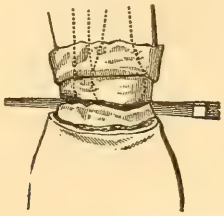
Only the scaphoid and semilunar enter into the articulation of the wrist-joint. These two bones constitute the ball or head, which is received into the socket formed by the lower end of the radius. The wrist-joint is therefore enarthrodial; and its socket is deepened, or prolonged, by the ulna upon the one side and the styloid process of the radius on the other. It is supported by a synovial membrane, lateral, anterior, and posterior ligaments, and by the flexor and extensor tendons, which, together, render its disarticulation very difficult, unless these supports have been previously divided.

The best guide to the joint is either the internal or external styloid process; between which points a line, drawn with its convexity towards the body, and about half an inch in depth, will indicate the articulation.

The surgeon must take special care in attempting to enter the joint, to keep his knife in the direction of this convexity, or he may fall between the two rows of carpal bones.

The circular method (Fig. 65) ought always to have the preference at this joint, since by it alone can we make certain that the expanded extremities of the radius and ulna will be completely buried by the flaps.

Fig. 65.



If the flap method is chosen, the incisions should be made from without, and not by transfixing. The principal flap should be from the palmar surface. (Fig. 66, 67.)

Fig. 66.

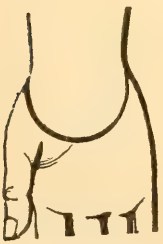
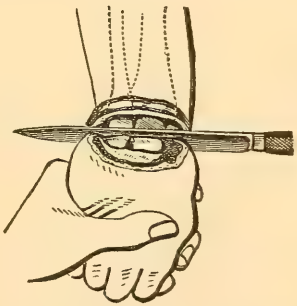


Fig. 67.



The radial, ulnar, and inter-osseous arteries may require the ligature.

FOREARM.

In the lower third of the forearm, where there is very little muscle, the circular amputation is preferred; but in the upper and middle thirds, where muscular structure is more abundant, and the conicity of the limb renders it difficult

to roll back the skin after the circular incision has been made, the flap method has the preference.

Amputation of any portion of the forearm requires usually the application of a tourniquet to the brachial artery, or that pressure should be made by the hands of an intelligent assistant. The incisions can be made by transfixing, or by cutting from without. A retractor, one yard in length by eight inches in breadth, is required, one end of which is torn longitudinally into three strips; the central strip is to be pushed between the bones, while the others are crossed from right to left, and from left to right, and drawn up to prepare the way for the saw.

In applying the saw, the bones should be laid parallel to each other; the radius should be severed first.

The radial and ulnar, with the anterior and posterior inter-osseous arteries, will probably require the ligature.

ELBOW-JOINT.

This is a ginglymoid articulation, and exceedingly irregular and complex in its construction. It is supported by a

Fig. 68.

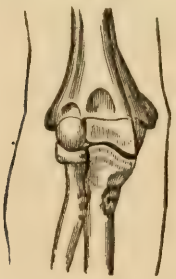
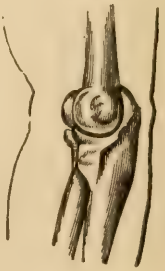


Fig. 69.



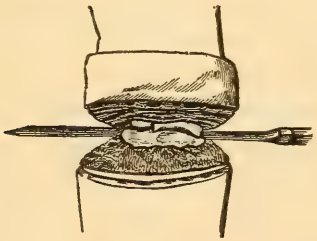
synovial capsule, with strong lateral, anterior, and posterior ligaments. It is reinforced also by the brachialis anticus, the triceps, and the anconeus, and receives more or less

support from the common tendons of the flexors and extensors of the forearm.

Upon the inner or ulnar side, the articulation will be found ordinarily in the adult, about three-quarters of an inch below the most prominent point of the internal condyle of the humerus; and upon the outer or radial side, a little more than one-quarter of an inch below the outer condyle.

The circular method has here two points of preference

Fig. 70.



It secures an ample covering for the expanded condyles of the humerus; and by dividing the brachial artery at the bend of the arm, only one ligature is required.

In making the circular amputation, the incision should commence at least three inches below the joint. The integuments being retracted, the head of the radius should be sought, and the external lateral ligament severed; after which, having divided all the muscles, including the tendon of the biceps and the brachialis anticus, the coronoid process of the ulna will be easily made out; the anterior ligament and the capsule may now be severed more completely, then the external lateral ligament. By moderate pressure upon the forearm the joint will now open sufficiently to admit the saw, if it is thought desirable to sever the olecranon process. It is a matter of indifference, per-

haps, whether we dissect out the olecranon by cutting the triceps from behind, or divide it with the saw applied as we have directed. We have generally preferred the latter mode as being more expeditious, and in the expectation that the triceps would resume its functions more completely when its attachment to the olecranon was maintained.

If the method by flaps is chosen, a small, posterior, tegumentary flap should first be made, and the skin should be dissected up as far as the base of the olecranon process, if this is to be sawed off, or as high as the top of the olecranon, in case it is not to be sawed. In the latter case, also, the surgeon may divide the triceps at its insertion before making the anterior flap.

The anterior flap is next made with a bistoury, commencing on the ulnar side three-quarters of an inch below the internal condyle, and terminating on the radial side half an inch below the outer condyle; the line of incision between these points being oval, with the convexity downwards. The length of the anterior flap should never be less than three or four inches, and it should include all of the muscular tissue down to the bone.

The most common error with the young surgeon is in commencing and terminating his incisions too high up—namely, opposite the condyles and not opposite the joint. The consequence of this error usually is, that he finds himself searching for the joint above the condyles. Let him follow the directions which have just been given, and search first for the head of the radius, and he will seldom go astray.

ARM.

The close adhesion of a large portion of the muscular tissue to the humerus in its lower part, prevents in some measure the danger of subsequent protrusion and exposure

of the bone; but as we approach the shoulder-joint this danger is increased by the looseness of the sub-muscular cellular tissue, and the freedom with which the muscles retract when their lower attachments are severed. In amputations high up, the flaps must be longer, to compensate for this retraction.

As to the mode of operation, there is really very little to choose between the various plans which have been devised.

The operation can be made most speedily and quite as neatly, we think, as by any other method, in the following manner:—

The operator, having grasped with his left hand as much of the integuments and muscles as possible upon the outside of the arm, transfixes the arm with a narrow, straight amputating knife, hugging the bone as closely as he can, and immediately carries the knife first downwards along the bone one inch or more, then outwards and downwards until the flap is of sufficient length, and finally almost directly outwards. This gives to the flap the shape of a perfect oval, and retains a proper thickness of muscular tissue to the very extremity of the flap.

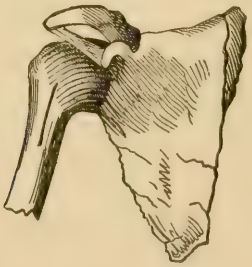
The second flap is then to be made with the same knife, or with a bistoury, as the surgeon may choose, by making a similar oval incision upon the inner side, cutting from without in. The advantage which will be gained by this method of making the second flap, will be found to be that the knife will have made a more complete sweep of the bone than can ever be done by transfixion, and the muscular tissue will at once be divided nearly or quite to the point where the bone is to be sawed.

The flesh being drawn back by a retractor and the bone sawed off as high as possible, it only remains to tie the brachial artery and possibly one or two smaller branches.

SHOULDER-JOINT.

This joint is enarthrodial—ball and socket—but the socket is very small in proportion to the size of the head of the humerus, which constitutes the ball; consequently it is disarticulated with great ease when the surrounding tissues are severed. The head of the humerus is maintained in its position by the capsule; which in turn is reinforced above and in front by the coraco-humeral ligament, a fibrous lamellated band which passes from the greater tuberosity of the humerus, and is inserted into

Fig. 71.



the coracoid process; by the long tendon of the biceps, which passes through the capsule and is inserted into the upper edge of the glenoid cavity; above and behind by the supra-spinatus muscle, which is attached firmly to the capsule, and is inserted into the greater tuberosity of the humerus; below and behind by the infra-spinatus and teres minor, which are attached to the capsule and inserted into the greater tuberosity; below and in front by the subscapularis, which lies close upon the capsule and is inserted into the lesser or inner tuberosity of the humerus; directly below by the long head of the triceps, which is separated from the capsule by a small amount of

loose areolar tissue, and which is finally inserted into the lower edge of the glenoid cavity.

The deltoid, pectoralis major, and several other muscles which more or less cover in the articulation, are not immediately interested in its support.

The most important anatomical circumstance relating to amputations at the shoulder-joint, is the position of the acromion and coracoid processes, with their intermediate ligament, called coraco-acromial; which together form a deep fibro-osseous arch of about one inch in perpendicular and the same in horizontal depth, and into which the upper end of the humerus is projected until it approaches within one-fourth of an inch of the concave surface of this vaulted arcade. It is this peculiar anatomical arrangement alone which renders it difficult to approach the capsule of the joint, and its other immediate investments.

There is no mode of amputation at the shoulder-joint which we have practised with so much satisfaction and ease as the following:

The arm lying nearly against the side of the body, with a large bistoury or a small dissecting-knife, an incision is commenced at the middle point of the extremity of the acromion process, or two or three lines above this point, and carried perpendicularly downwards one inch and a half, the knife being made to cut deeply until it touches the head of the humerus; at this point the knife is carried obliquely, and rather abruptly, outwards and downwards to the centre of the lower margin of the axilla on the under side of the arm; in this second step of this incision, the tissues are divided down to the bone until the axillary margin is reached; from this point to the termination of the incision, only the integuments are divided, so that we may avoid wounding the axillary artery. The knife is again introduced over

the head of the humerus, at the point where the perpendicular incision became oblique, and it is carried down upon the inside of the arm in the same manner as we have described upon the outside.

Fig. 72.

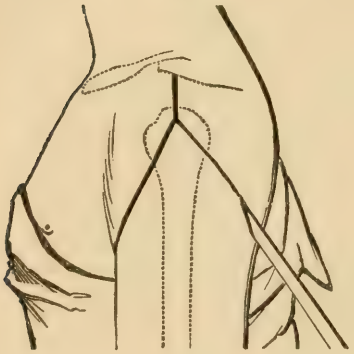
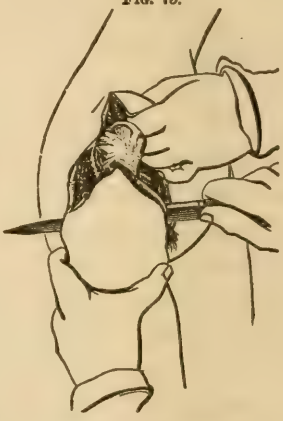


Fig. 73.



One assistant pulling asunder the lips of the wound upon the top of the shoulder, while a second carries the elbow slightly across the body, and rotates the head of the humerus outwards, so as to expose the capsule and the long head of the biceps, the surgeon divides them with his knife, and at the same moment the head of the humerus springs from its socket.

The knife is then passed under the head of the bone from above, cutting such portions of the capsule, the supra- and infra-spinatus or subscapularis as have not already been divided; and as soon as the face of the instrument has fairly reached the surgical neck of the humerus, an assistant, standing at the head of the patient, pushes the thumbs of both hands into the wound above the knife, while the fingers remain in the axilla, and he thus grasps and controls the axillary artery.

The operation is completed by carrying the knife downwards, close to the bone, until the apex of the tegumentary wound in the axilla is reached, and then cutting almost directly outwards. In this last part of the operation the arm must be lifted again from the body. The surgeon also must take care that he does not sever the parts containing the artery until he has arrived at the lower margin of the axilla.

By this method, which is only a slight modification of that recommended by Larrey and Guthrie, it is possible to amputate the limb without losing more than a few drachms of blood, even though the artery is not compressed upon the first rib; but it will not interfere with this additional precaution being taken, if the surgeon desires to do so. The two circumflex arteries which are cut in the early parts of the incision, may be temporarily held by the fingers of an assistant; or they may be allowed to bleed until the operation is completed.

AMPUTATION OF LOWER EXTREMITIES.

The anatomy of the toes does not differ essentially from that of the fingers. The phalanges of the toes are shorter, broader, and their articular surfaces, especially, are much more expanded.

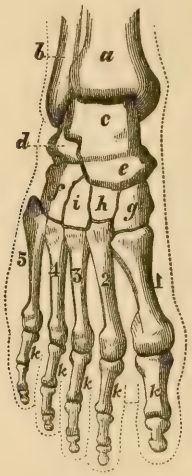
The rules which have been given for amputation of the fingers, either in their continuity or contiguity, will apply here.

The surgeon will not forget that there are, usually, two or three sesamoid bones underneath the metatarso-phalangeal articulation of the great toe, and that the distal end of this metatarsal bone is very large, and requires an ample flap to cover it.

Disarticulation of all the toes at the metatarso-phalan-

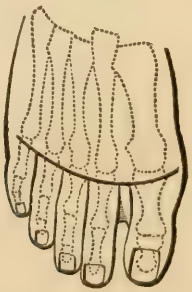
geal articulation is best made by a double flap—plantar and dorsal—the plantar flap being the longest. The operation

Fig. 74.



In the accompanying wood-cut, *a* and *b* represent the inferior extremity of the tibia and fibula; *c*, astragalus; *d*, os calcis; *e*, naviculare; *f*, cuboid; *g*, internal cuneiform; *h*, middle cuneiform; *i*, external cuneiform; 1, 2, 3, 4, 5, first, second, third, fourth, and fifth metatarsal bones; *k*, *k*, *k*, *k*, *k*, phalanges of the toes.

Fig. 75.



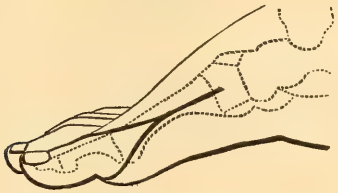
may be made with a convex bistoury, the incisions being made from the surface. (Fig. 75.)

METATARSAL BONES.

The method of disarticulating a single metatarsal bone is also nearly identical with that employed in the disarticulation of individual metacarpal bones.

In amputating the metatarsal bone of the great toe, the articulation will be found about two lines back of the slight prominence occasioned by the expansion of the proximal end of the bone, and about one inch in front of the naviculare. The arteria dorsalis pedis dips down to the

FIG. 76.



sole of the foot, just below this joint, passing between the metatarsal bones of the great and adjoining toes.

The metatarsal bone of the little toe articulates with the cuboid and with the adjoining metatarsal bone. The arti-

FIG. 77.

FIG. 78.

culation can be easily made out by the projection upon the outer side of its proximal end, into which is inserted the

peroneus brevis. The line of articulation is very obliquely forwards and inwards. (Fig. 79.)

Fig. 79.

Before making an amputation of all the metatarsal bones through their tarso-metatarsal articulations, we must

Fig. 80.

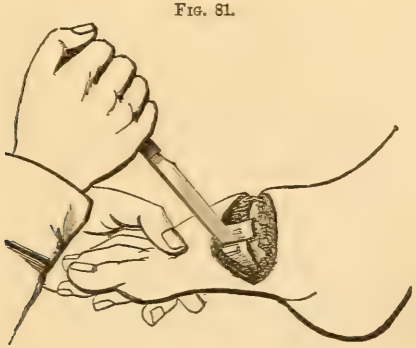
consider certain anatomical points. The guides to the metatarso-phalangeal articulations of the great and little toes have already been mentioned.

All of these articulations are supported by dorsal, plantar, and inter-osseous ligaments, the latter of which are most important to the operator.

The inter-osseous ligaments are three in number. The first or internal, which is called the "key" of the whole articulation, arises between and from the first and second cuneiform bones, and is inserted into the corresponding surfaces of the first and second metatarsal bones. The second metatarsal bone being received into a kind of mortise formed of the three cuneiform bones, is locked in chiefly by this ligament; the second ligament being smaller and contributing much less to the security of the joint.

Our method of operating is as follows:—With a convex bistoury an incision is made on the dorsum of the foot, commencing one inch in front of the tarso-metatarsal articulation on the outer side of the little toe, if it is the left foot, and extending in a curved line to the same point on the inner side of the great toe. The integuments are now carried back, having first extended the two ends of the

FIG. 81.

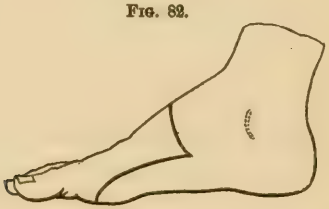


incision upwards one inch, until the articulations of the first and fifth toes are clearly made out and partially entered. The point of the knife is now made to penetrate

the inner or tibial side of the mortise which receives the second metatarsal bone, in order to cut the internal inter-osseous ligaments, which lie deep between the bones. (Fig. 81.) The ligaments on the outside of the mortise are cut in the same manner. As soon as their section is accomplished and the dorsal ligaments are cut, a moderate pressure applied to the ends of the foot springs open the entire articulation. A second and larger flap is now made on the plantar surface; cutting from without in, the plantar ligaments are divided and the operation is completed. (Fig. 82.)

In this, as in all other amputations on the foot, the flaps must be long or the ends of the bones will project as soon as the patient begins to walk.

Fig. 82.



Amputations of the metatarsal bones in their continuity may be made in the same manner, with dorsal and plantar flaps, the bones being divided by either a fine saw or the bone-cutters; we prefer the latter generally, if the instrument is in good order.

MEDIO-TARSAL ARTICULATION.

This articulation is formed by the calcaneum and astragalus on the one hand, and the cuboid and naviculare on the other. It is supported by dorsal, plantar, and inter-osseous ligaments; the inter-osseous ligament extending from the two first to the two last named bones, being the strongest.

The line of the articulation, commencing on the outside, is found about half an inch behind the proximal end of the fifth metatarsal bone, or just in front of a slight projection made by the outer surface of the calcaneum ; on the top of the foot the articulation is immediately in front of the head of the astragalus, which is made prominent by extending and adducting the foot; on the inside it may be found about half an inch in front of the malleolus internus, immediately behind a considerable prominence, which is caused by the naviculare.

When the foot is flexed, or bent upwards towards the leg, the anterior or articular surfaces of the astragalus and calcaneum are almost in the same line; when it is extended, the calcaneum is about one-quarter of an inch more in advance.

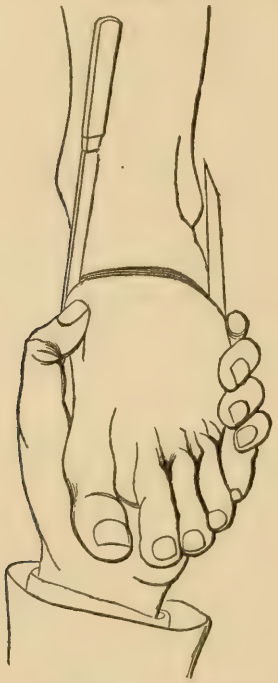
Entering the articulation either from the outer or inner margin of the foot, the knife must be directed obliquely forwards, at an angle of about forty-five degrees with the axis of the foot.

The amputation should be made with a small amputating-knife, or a bistoury. There should be two flaps, a dorsal and a plantar, the latter being the principal flap. The dorsal should be made first. (Fig. 83.) In the first part of the incisions, and until the top of the joint is opened, the foot must be kept extended, so as to avoid entering the joint below the naviculare; when the top of the joint is fairly opened, the foot should be flexed so as to bring the anterior extremities of the calcaneum and astragalus on the same line. The surgeon must take care, also, in the first part of the incisions, while searching for the joint upon the top of the foot, not to go above the head of the astragalus.

Both flaps should be made from the surface, and not by transfixion. The plantar flap must be long.

To cut the inter-osseous ligament, after having divided the dorsal, the point of the knife must be introduced per-

Fig. 88.



pendicularly, at the outer and anterior margin of the astragalus ; and by depressing the handle of the knife towards the toes, the ligament will be severed.

This operation, first recommended by Chopart, is liable to be followed by a contraction of the tendo-Achillis, and a consequent displacement of the end of the stump downwards. Careful attention to the position of the foot after the amputation, will sometimes prevent this accident; in other cases it has been found necessary to sever the tendo-Achillis.

Baudens has sought to avoid the displacement of the stump by leaving the naviculare and one-half of the cuboid, but the operation has nothing to recommend it.

ANKLE-JOINT.

The ankle-joint is ginglymoid, or hinge-like, admitting of no other motions than flexion and extension.

The bones which compose the ankle-joint are the tibia and fibula on the one hand, and the astragalus on the other; the astragalus being received into the deep mortise formed by the external and internal malleoli.

The joint is supported by the capsule and three ligaments, namely, the external, internal, and anterior.

When the foot is extended, this articulation is easily approached from the front.

Syme's method of performing this amputation, which is now generally adopted, is essentially as follows:

The posterior flap is formed by entering the knife at the centre of the lower end of the malleolus externus or internus, and carrying it perpendicularly across the sole of the foot to the corresponding point of the opposite malleolus.

The anterior flap is formed by commencing the incision at the same point upon one side, and carrying it across the top of the foot in a straight line to the opposite extremity of the first incision. The mode of making these incisions is nearly the same as in Pirogoff's operation, illustrated in fig. 85.

The articulation may now be entered in front, and the astragalus partially disarticulated before dissecting up the posterior flap. This will be found to greatly facilitate the removal of the calcaneum in the latter part of the operation.

The posterior or plantar flap (Fig. 84) must then be dissected carefully from the calcaneum, commencing from below. This part of the operation must be made slowly

Fig. 84.

and cautiously, lest the integument should be cut through with the knife, or the posterior tibial artery should be wounded before it has divided into the internal and external plantar arteries. If this accident happens the flap will be in danger of sloughing.

Before the separation of this flap is completed the surgeon will find it convenient to disarticulate the foot completely, and to cut the tendo-Achillis and the remaining posterior attachments from behind.

The operation is completed by exposing the malleoli, and sawing them off, including, if the surgeon sees fit, a thin slice of the lower end of the articulating surface of the tibia.

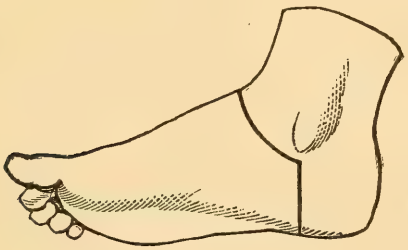
To prevent the blood or pus from accumulating in the

posterior flap, which forms a shallow pouch, the flap should be compressed moderately against the lower end of the bones.

PIROGOFF'S METHOD.

Pirogoff, of the Russian Army, proposed to save a portion of the calcaneum and thus increase the length of the limb, while at the same time he believed the stump would possess more solidity and firmness. He describes his method of operation as follows:

FIG. 85.



"I commence my incision close in front of the outer malleolus, carry it vertically downwards to the sole of the foot, then transversely across the sole, and lastly obliquely upwards to the inner malleolus (Fig. 85). Thus all the soft parts are divided at once quite down to the os calcis. I now connect the outer and inner extremity of this first incision by a second semilunar incision, the convexity of which looks forward, carried a few lines anterior to the tibio-tarsal articulation. I cut through all the soft parts at once down to the bones, and then proceed to open the joint from the front, cutting through the lateral ligaments, and thus exarticulate the head of the astragalus. I now place a small narrow amputation-saw obliquely upon the os calcis behind the astragalus, exactly upon the sustentaculum

tali (Fig. 87), and saw through the os calcis, so that the saw passes into the first incision through the soft parts. Saw carefully, or the anterior surface of the tendo-Achillis,

Fig. 86.

which is only covered by a layer of fat and a thin fibrous sheath, might be injured. I separate the short anterior flap from the two malleoli, and saw through them at the same time close to their base. I turn this flap forwards, and bring the cut surface of the os calcis in apposition with the articular surface of the tibia. If the latter be diseased it is sometimes necessary also to saw off from it a thin slice with the malleoli."

LEG, IN ITS CONTINUITY.

In the lower third of the leg the circular amputation has the preference; the coverings for the bone must be entirely tegumentary.

If the tourniquet is employed, it should be applied to the popliteal artery rather than to the femoral. In proportion as the tourniquet is applied nearer to the body, the greater will be the loss of blood occasioned by the strangulation of the limb.

In order to effectually compress the popliteal artery, which lies in the popliteal space, very close to the bones, a large square compress, one or two inches in thickness, should be placed between the hamstrings, and a thinner

compress should be placed upon the top of the knee, just above the patella, to protect the limb from the direct pressure of the frame of the instrument. Applied in this way the circulation may be completely controlled, while the motions of the knee-joint are not essentially interfered with.

In making the circular amputation, whether through the leg, at any point in its continuity, or at the knee-joint or through any portion of the thigh, we have for some time practised the following method:

The knife, instead of making the complete circuit of the limb, in a line at a right angle to its axis, when it nearly reaches the centre of the limb behind, is carried through a short curve directly upwards or in the direction of the axis of the limb, one, two, or more inches. (Fig. 87.) The opposite extremity of the circular incision terminating in the same manner and at the same point.

This practice we adopt equally when the first incision includes only integument, and when it includes both integument and the superficial muscles.

The extent of the vertical incision behind will be determined by the length which is proposed to be given to the circular flap, or, in other words, by the diameter of the limb.

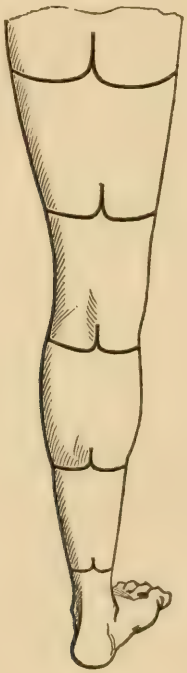
The integument being now turned up and dissected from the fascia two or three inches, the second incision is made fairly down to the bones; and the bones are divided as high as possible underneath the muscles.

The advantages of this method are, the greater ease with which the skin is rolled back, so that the circular amputation can be employed even when the limb is conical, with the base of the cone directed towards the body; and the free opening which is left below for the discharge of blood and pus.

In making the section of the bones, the fibula ought

always to be completely severed first, and if possible a very little higher than the tibia.

Fig. 87.



The anterior and posterior tibial, and the fibular arteries, will require the ligature.

After the limb is dressed, care must be taken not to leave the end of the stump too depending.

In amputating at the middle or upper thirds of the leg, it is perhaps a matter of indifference whether we adopt the flap or circular methods.

The flap amputation is made as follows (Fig. 88):—The limb being elevated a few seconds immediately before tight-

ening the tourniquet, so as to drain it of blood as completely as possible, the surgeon, with a common scalpel, makes a short anterior flap, with its convexity directed downwards,

Fig. 88.

and extending from the outer and posterior margin of the fibula on the one hand to the inner and posterior margin of the tibia on the other. This flap, entirely tegumentary, and not more than one inch and a quarter in length, is immediately raised by moderate traction and a few strokes of the knife.

The second flap is made with a catlin or an amputating knife, by transfixing the leg close under the bones, the points of entrance and of exit of the knife corresponding to the two extremities of the first incision. In order to accomplish this easily, the posterior flap must be grasped by the left hand of the operator, the thumb and forefinger resting in the two extremities of the first incision. The knife must now descend, with a sawing motion, about two inches along the back of the tibia and fibula, and then be brought out to the surface in a curvilinear direction.

We insist upon the directions given, to hug the bones at first, and then bring the knife out to the surface in the segment of a circle, as essential to the formation of a good flap, not only here but wherever the method by flaps is adopted. When the knife is brought to the surface by an oblique incision, commencing from the point of transfixion, the vessels, nerves, tendons, muscles, and even the skin,

are shaved off obliquely, and are much more apt to slough and to give rise to other serious accidents.

In dividing the bones, the fibula must be sawed first, and certainly as high as the tibia. After the section of the bones is completed, with the saw or the bone-cutters the apex of the spine of the tibia should be cut away, or it will almost certainly, sooner or later, protrude and exfoliate.

KNEE-JOINT.

(*For Anatomy of this joint see Exsections of Knee.*)

Our own method is as follows:—The limb having been relieved in some measure of its blood by elevation, the tourniquet, applied to the femoral artery, is tightened; the leg being flexed slightly on the thigh, with a convex bistoury a circular incision is made three or four inches below the knee, terminating behind in the manner which we have already described for circular amputations in the continuity of the leg. By traction and dissection, the ligamentum patellæ is now exposed and severed; the capsule, lateral ligaments and hamstrings are cut; the crucial ligaments divided—leaving nothing farther to be severed but the posterior ligaments of the joint, and that small portion of structure in the popliteal space which contains the popliteal vessels.

The surgeon will now seize these tissues between his thumb and forefinger and divide them a little lower down.

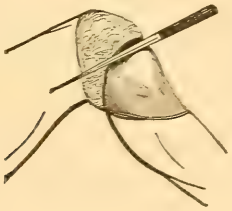
In some cases, in operating by this method, we do not think it necessary to employ a tourniquet.

In case the flap is not found to be sufficient, the patella may be removed, to prevent retraction of the flaps through the action of the quadriceps femoris; or, more or less of the condyles of the femur may be sawed off. If the con-

dyles are removed, great care must be taken to tie the articular arteries above the joint, or a troublesome secondary hæmorrhage may ensue. We have seen this occur several times.

The oval method represented in Fig. 89 may be adopted

Fig. 89.



if the surgeon chooses. It is especially recommended by Malgaigne.

THIGH IN ITS CONTINUITY.

The method by flaps has here generally been preferred.

In general, the flaps should be made from the anterior and posterior surfaces. Lateral flaps endanger the protrusion of the bone at the superior angle.

In order that the first or anterior flap may be made from those muscles which contain the fewest vessels, the knife is generally introduced obliquely downwards and outwards (Fig. 90).

The instructions which have been given when describing amputation of the leg by the flap method, must be observed equally in this case, namely, to carry the knife after transfixion, first directly downwards along the surface of the bone, two or three inches, and then outwards in the line of the segment of a circle.

The circular amputation should be made as we have directed in amputations of the leg. In the case of feeble

Fig. 90.

or anæmic patients, the first incisions should include more or less of the superficial muscles with the skin.

We think it necessary to repeat here the instruction given in the case of other amputations, namely, that the surgeon should expose the bone underneath the flaps for some distance before applying the saw. Protrusion and exfoliation of the bone are much more often due to a neglect of this precept than to the shortness of the flaps. While peeling up the periosteum, he must take care also not to disturb it at a point any higher than the saw is to be applied.

HIP-JOINT.

The coxo-femoral articulation is composed of two bones, which are joined to each other by ball and socket; the socket is deeper than any other in the body; but notwithstanding its great depth it does not at any time receive more than one-third of the head of the femur.

The head of the femur is retained in its position by the round ligament and the capsular, the latter being reinforced by the ilio-femoral and the transverse. The ilio-femoral

and transverse may be considered as practically parts of the capsular.

The capsular ligament embraces the round head of the femur and the neck so closely that its division opposite the neck will not enable the operator to open into the acetabulum in order to reach the round ligament; the capsule must, therefore, be divided as closely as possible to the margin of the acetabulum. The round ligament has sufficient length to allow the head of the femur to fall almost completely out of the socket when the capsule is entirely severed.

A large mass of muscular structure surrounds the joint on all sides, but less in front than elsewhere, from which direction alone the head of the femur can be usually felt and easily approached.

The trochanter major projects upwards and backwards about three-quarters of an inch above the neck of the femur.

The important arteries concerned in an amputation at this point are the femoral, obturator, ischiatic, gluteal, with perhaps the external and internal circumflex.

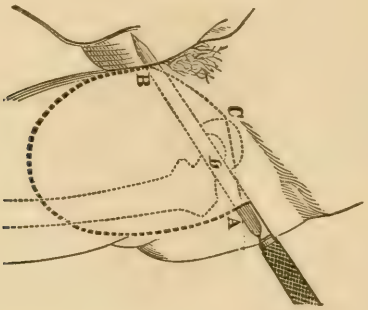
Several different modes of amputation at the hip-joint have been recommended and practised by different operators.

The single anterior flap method, regarded by Malgaigne and Guerin as superior to all others, is described by Smith as follows (Fig. 91):

"The patient lying upon the edge of the table, the hip projecting, the artery is compressed upon the horizontal branch of the pubes; the operator then takes a position on the outside of the limb (the left), which is separated from the other and slightly flexed on the pelvis, and raising the soft parts, which cover the anterior face of the limb, enters a very long double-bladed knife midway between the great

trochanter and the anterior superior spine of the ilium, directing it at first slightly from below upwards, and from without inwards, A, C, so as to reach the head of the femur, and open the capsule of the joint;

Fig. 91.



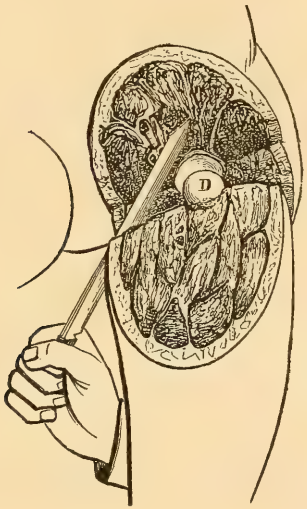
he now eleva'es the handle, and carries the knife in the direction A, B, the point emerging about an inch below and in front of the tuberosity of the ischium; the knife is then carried downwards along the anterior surface of the bone, and a large semilunar flap is made, extending nearly half the length of the thigh, or six inches; care should be taken that the flap is as long on the inside as on the outside; an assistant raises the flap, at the same time compressing the artery which it contains; the knife is now applied to the capsule, which is divided close to the acetabulum, as if about to cut across the middle of the head of the femur, D (fig. 92), and at least half of its circumference; the limb is then abducted to luxate the head of the bone, the knife passed behind it, and the soft parts on the posterior portion of the limb divided as in the circular operation." (Fig. 92.)

The following is Lisfranc's double lateral flap method (Fig. 93):

"The patient must be laid upon his back with the tuberosities of the ischia projecting slightly beyond the edge of the bed, and the limb held in a position between abduction and adduction. Then having determined, by the anatomical rules laid down, the anterior and

external side of the articulation, the operator, holding perpendicularly a long double-edged knife, introduces it at this point, with its lower

Fig. 92.



edge looking downwards towards the great trochanter. As the point of the knife enters, it should be carried around the head of the femur

Fig. 93.

on its outer side, whilst its handle is inclined upwards and outwards, and pushed steadily on in this direction, so that it perforates the integuments a few lines below the tuberosity of the ischium. While this is being done, an assistant grasps the tissues over the trochanter and carries them outwards, in order to assist in the formation of the

external flap, and the knife is carried downwards and outwards with a slightly sawing motion, around the great trochanter, and along the femur, cutting out a flap from three to four inches in length. The first flap being thus made, the operator, grasping the tissues on the inside of the thigh and carrying them inwards, introduces the knife below the head of the femur and on the inner side of its neck, holding it in a perpendicular position. As it enters, the point of the knife should pass around the neck of the femur and come out at the lower angle of the wound already made, without coming in contact with the bones of the pelvis; it is then carried downwards along the femur, and avoiding the lesser trochanter, so as to make an internal flap of the same length as the external. The flaps being drawn aside by the assistants, and the arteries tied, the surgeon grasps the femur with his left hand, and holding the knife perpendicularly on the inner side of the head of the bone, cuts the capsular ligament without attempting to penetrate the articulation. The joint being opened, the disarticulation is concluded by cutting the fibrous and muscular tissues which remain."—Smith.

Fergusson recommends a double flap, antero-posterior, method (Fig. 94).

Fig. 94.

"The surgeon, standing on the outside of the limb, should insert the point of a long catlin about midway between the anterior superior spinous process of the ilium and trochanter major, keeping it

rather nearer the former than the latter; he should then run it across the fore part of the neck of the bone, and push it through the skin on the opposite side, about two or three inches from the anus; next, he should carry it downwards and forwards, so as to cut a flap from the anterior aspect of the thigh, about four or six inches in length. When the blade is entered, the limb should be held up, and even slightly bent at the joint; the instrument will then pass along more readily than if all the textures were thrown on the stretch; moreover, there is greater certainty of passing it behind the main vessels, and even dividing some of the fibres, if not the whole, of the iliacus internus and psoas muscles. As the knife is carried downwards, the assistant who stands behind the operator, should slip his fingers into the wound and carry them sufficiently far across to enable him to grasp the femoral artery between them and the thumb: this he may do from the inside or outside at will, and with the right or left hand, as may be most convenient, the same grasp enabling him to raise the flap as soon as it is completed. The flap being raised, the point of the knife should then be struck against the head of the bone, so as to divide the anterior part of the capsular ligament and any textures in this situation which may not have been included in the flap. To facilitate this part of the operation, the knee should be forcibly depressed by the assistant who holds it; the head of the bone will thus be caused to start from its socket, and if the round ligament is not ruptured by the force, a slight touch with the edge of the knife will cause it to give way. At this period, depression being no longer required, the assistant should bring the head of the femur a little forwards, to allow the knife to be slipped over and behind it, and when it is in the position represented in the design, it should then be carried downwards and backwards, so as to form a flap somewhat longer than that in front, the last cut completing the separation of the limb.

"I have not inculcated the necessity of introducing the point of the blade a certain number of lines distant from the spine of the ilium, nor have I been very precise as to the exact distance from the anus at which it should protrude, for I believe that the operator, instead of limiting himself to lines here, may actually take the freedom of inches: his object should be to make as broad a flap in front as the method by transfixion will admit of; but whether he pushes in the knife, or brings it out, an inch above or the same length below a certain given

distance, seems to me of very little consequence: if he begins low down, he has to cut out so much deeper, as it were, ere he reaches the capsule, and if this is a disadvantage, it is, perhaps, compensated by the wound on and near the surface being a little further from the trunk: if he introduces the point much behind the tensor vaginæ femoris, he cannot with safety carry it so near the anus as if it were pushed in front of that muscle, and so what he strives for on one side is lost on the other."—Fergusson.

Guthrie prefers the oval method. (Fig. 95.)

"The patient is to be laid on a low table, or other convenient thing, in a horizontal position; an assistant, standing behind and leaning over, compresses the external iliac artery, becoming femoral as it

Fig. 95.

passes over the head of the pubes. The surgeon, standing on the inside, commences his first incision some three or four inches directly below the anterior spinous process of the ilium, carries it across the thigh through the integuments, inwards and backwards, in an oblique direction, at an equal distance from the tuberosity of the ischium to nearly opposite the spot where the incision commenced; the end of this incision is then to be carried upwards with a gentle curve behind the trochanter, until it meets with the commencement of the first, the second incision being rather less than one-third the length of the first. The integuments, including the fascia, being retracted, the three gluteal muscles are to be cut through to the bone. The

knife being then placed close to the retracted integuments, should be made to cut through everything on the anterior part and inside of the thigh. The femoral or other large artery should then be drawn out by a tenaculum or spring forceps, and tied. The capsular ligament being well opened, and the ligamentum teres divided, the knife should be passed behind the head of the bone thus dislocated, and made to cut its way out, care being taken not to have too large a quantity of muscle on the under part, or the integuments will not cover the wound, under which circumstance a sufficient portion of muscular fibre must be cut away. The obturatrix, gluteal, and ischiatic arteries are not to be feared, being each readily compressed by a finger until they can be duly secured. The capsular ligament, and as much of the ligamentous edge of the acetabulum as can be readily cut off, should be removed. The nerves, if long, are to be cut short. The wound is then to be carefully cleansed, and brought together by three or more soft leaden sutures in a line from the spine of the ilium towards the tuberosity of the ischium. * * * This mode of proceeding is more certain of making good flaps where integuments are scarce. Where the integuments will admit of the anterior flap being made by the sharp-pointed puncturing knife dividing the parts after it has been passed across from without inwards, there is no objection to this proceeding, and some prefer it."—GUTHRIE.

Abernethy amputated by the circular method. Many other modifications of these several modes have been practised by different surgeons; indeed, scarcely any two operators have adopted the same procedure. The results have not yet demonstrated the value of one method over another; and the surgeon may properly consider himself at liberty to make his own choice.

V. Mott, Delpech, Blandin, and others, have tied the femoral artery before commencing the amputation. Larrey commenced by tying both the femoral artery and vein.

Malgaigne, Guerin, Beclard, prefer that the femoral artery shall be controlled by compression upon the pubes, made by the hands of an assistant.

Lalouette employed for the purpose a tourniquet.

Lenoir, Lisfranc, Fergusson, Shippen, are contented with pressure made upon the artery by the hands of an assistant by grasping the anterior flap after it is partly raised, and before the section of the vessels is completed.

As we have mentioned in our general remarks, amputation at the hip-joint for gunshot injuries has been made five times during the present war, and perhaps oftener. In two instances the operation has been successful. The following is a brief account of Dr. Fenner's operation, given to the author by his very intelligent private pupil, Mr. W. L. Henderson, who was present at the time:

The operation was made at Memphis, Tenn., in March, 1862, upon a confederate soldier who had received on the day before a gunshot injury of the left thigh, involving the hip-joint. He was placed under the influence of chloroform. Mr. Henderson saw this man as late as four months after the operation, and he was then perfectly well and employed as a laborer at the foundry.

We have been able to obtain also a very complete account of the case of successful amputation made by our much esteemed friend, Surgeon Edward Shippen, U.S.V. It will be found embodied in the following communications.

HEAD-QUARTERS, 23D ARMY CORPS, MEDICAL DIRECTOR'S OFFICE,
Near Marietta, Georgia, *June 30th*, 1864.

DEAR DOCTOR:—The following is a history of the case of amputation at the hip-joint which you desired me to send you:

James Kelly, a private of Co. B, 56th Penn. Vols., was wounded on the 29th of April, 1863, in the attack made by the 1st Div. 1st Corps, on the enemy's rifle-pits on the south side of the Rappahannock, and nearly opposite to Pratt's house, about two miles below Fredericksburg.

The wound was caused by a minié ball, which struck the left femur about two inches below the great trochanter, producing a compound comminuted fracture, and splintering the bone as high as the trochanter.

Upon consultation with the Surgeons-in-chief of the Brigades attached to the Division, it was decided that, in order to give the man a chance for his life, amputation at the hip-joint should be performed. I accordingly operated, being very ably assisted by several army medical officers. The patient being fully under the influence of chloroform, was placed on the operating-table, his nates being brought well over to the edge. A ten-inch catlin was then introduced about midway between the trochanter major and the anterior superior spinous process of the ilium, the point at first being directed slightly upwards in order to open the capsule of the joint; then the handle was raised and the point made to come out about an inch in advance of the tuberosity of the ischium. A large flap was then cut from the anterior and inner side of the thigh, about six inches in length; the hæmorrhage being controlled by Dr. Murdock grasping the flap and compressing the femoral artery before it was cut. The heel of the knife was then placed where the point came out, and the points of entrance and exit joined by an incision, cutting to the bone. Part of the capsule being opened by the first incision, the remainder of it was divided, the round ligament cut, and the head of the femur removed from the acetabulum. The hæmorrhage was then arrested, the femoral artery being tied last. The loss of blood was very slight, not being as great as in an ordinary amputation of the thigh.

The operation was "primary," being performed within five hours after the reception of the wound.

The patient was afterwards placed in a hospital-tent and remained under my charge till May 2d, when, as our Division was ordered to move to Chancellorsville, he was transferred to the Corps Hospital at the "Fitz-Hugh House," under the charge of Surgeon Whitney, 13th Mass. Vols.

I did not see him again till May 9th, when the Division having returned to its former position, I was enabled to pay him a visit. He was doing very well, and Surgeon Whitney informed me that no unfavorable symptoms had shown themselves since he had come under his charge. He continued to improve daily, the stump granulating

finely, and on May 28th I removed the ligatures. On June 5th received an order assigning me to duty with the 1st Division, 5th Corps, and consequently after that date saw no more of Kelly; but up to the time of my leaving the Division, he was doing remarkably well.

Soon after this the Army of the Potomac moved after the rebel army, who were then advancing into Pennsylvania, and the sick and wounded at the Fitz-Hugh House were captured and removed to Richmond, private Kelly being among the number.

The following is a copy of a letter which was furnished me by Surgeon Vanderkieft, U.S. Vols., in charge of U.S.A. General Hospital, Division No. 1, Annapolis, Md., under whose care Kelly came after being released from the Libby Prison at Richmond:

U.S. General Hospital, Div. No. 1,
Annapolis, Md. *August 19th*, 1863.

Sir:—In reference to the case of amputation mentioned in the accompanying letter, I have the honor to report that private Kelly, wounded on the 26th of April, 1863, and upon whom you made an amputation at the left hip-joint, was taken prisoner June 15th, 1863, and confined in Libby Prison, Richmond, Va. He remained in prison until July 14th, 1863, when he was released and sent to this hospital. On admission here he was very much debilitated, and had a severe diarrhœa, having as many as fifteen passages a day.

The lips of the flaps had all united, except the lower internal portion, which was in a gangrenous condition, having been attacked with hospital gangrene while in Libby Prison, about the 8th of July.

After admission here, I ordered pills of opium, ipecac., and sub-nitrate of bismuth for his diarrhœa, with beef-essence and rice-jelly as diet. Tinct. chlor. iron was administered internally, twenty drops three times a day; I made free use of bromine locally, but after three days' trial, finding that the sloughing still continued, I stopped it and ordered a local application of Liq. sodæ chlor., much diluted with water. This solution was not only applied by means of linen kept wet with it, but was thrown under the slough as much as possible by means of a large syringe. On the eighth day after admission the slough came away, leaving a clean, healthy surface, which would

easily accommodate a man's hand. The patient has continued to improve ever since, and is now, I consider, out of danger.

I am, Sir, very respectfully,
Your Ob't Serv't,
(Signed) MATHEW STOVELL,
A. A. Surgeon, U.S.V.

To B. A. VANDERKIEFT, Surgeon, U.S.V., in charge.

From this time Kelly continued rapidly to improve, and on Nov. 23d, 1863, I received a letter from him in which he said:—"I can run all over on my crutches. I have been out in the town a number of times, and I can go as well as most any other person on them."

Truly yours,
EDWARD SHIPPEN.

FRANK H. HAMILTON, M.D., New York.

Surgeon Shippen adds in a postscript: "I have operated twice since at the hip-joint, and in both cases the patients died within an hour after the operation; death appearing to be caused by the shock, as in neither case was there sufficient hæmorrhage to account for it.

"I have not heard of any other successful cases of amputation at this joint during the present war."

In one other case, the operation having been made by Dr. Carnochan of this city, during the battles of the Wilderness, the operation, we are informed, resulted in death about one hour after the operation was completed. Dr. Gross, of Philadelphia, in reply to a note addressed to him, has furnished the following interesting and unique case of successful amputation at the hip-joint:

PHILADELPHIA, *July 15th*, 1864.

MY DEAR DOCTOR:—In 1861 I operated upon a man, aged 79, who had been wounded at the battle of Moscow, in the inferior third of the leg, between the tibia and fibula. The ball, weighing six drachms and a half, and covered with numerous facets, as if it had been cut to fit the musket, had remained quiescent for forty-nine years, when it

began to excite inflammation, followed by excessive pain and profuse discharge. Upon examination, I found a large mass of bony matter, evidently caused by calcification of the cyst in which the ball had been so long inclosed. The man recovered without an untoward symptom, and is still alive.

Yours very truly,

S. D. Gross.

Professor Hamilton.

CHAPTER XIX.

EXSECTIONS.

EXSECTION, or resection of bones, practised more or less from the earliest periods, has assumed its chief importance only within the last few years. At the present moment, regarded as a substitute for amputations, it is believed to be a positive advance in conservative surgery.

Exsections are naturally divided into those operations of this class made in the continuity or shafts of the long bones; operations in the contiguity or at the articulating surfaces; and operations involving the removal of entire bones.

These operations also, like amputations, may be immediate, primary, intermediate, or secondary.

It is impossible in a general treatise to discuss at length all the varieties of these operations; nor is it essential to a proper understanding of the subject that this should be done. The rules which will govern the operator in the selection of the period for operation will not vary materially from those given for amputations. As to the class of cases which will demand exsection, some indications have already been given when treating of amputations; many cases must be left to the judgment of the surgeon, and a few will require in this place special consideration.

The instruments, in addition to those usually found in operating cases, which have been found serviceable in exsections are—metallic retractors; steel chisels and gouges; a metallic hammer; straight (Fig. 96) and curved (Figs. 97,

98) bone-cutters; strong forceps for holding the bone, like

Fig. 97.

Fig. 96.

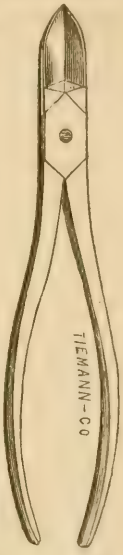
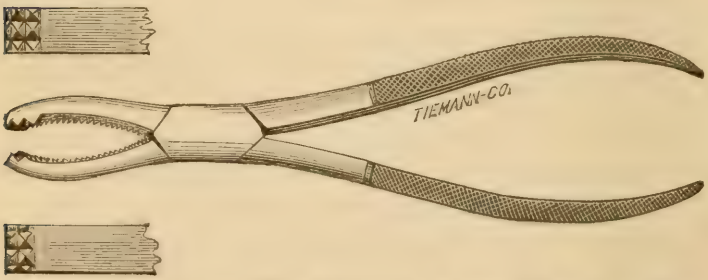


Fig. 98.

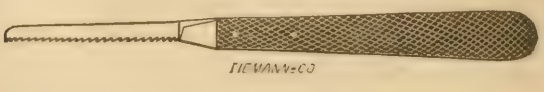
that recommended by Chassaignac, and improved by Halstead of New York (Fig. 99); a cartilage knife; a nar-

Fig. 99.



row, straight saw (Fig. 100), or a saw with a movable

Fig. 100.

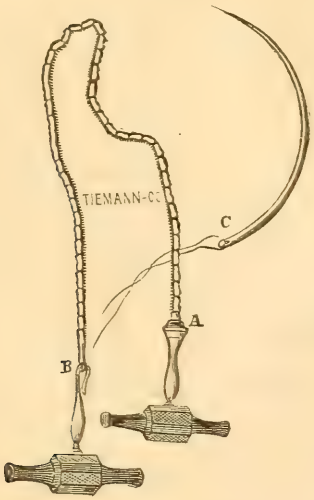


blade (Fig. 101); a chain saw, with Tiemann's rotating

Fig. 101.

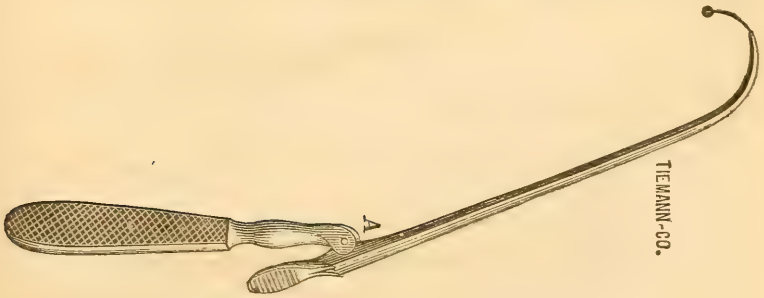
handles (Fig. 102), and an instrument for passing the

Fig. 102.



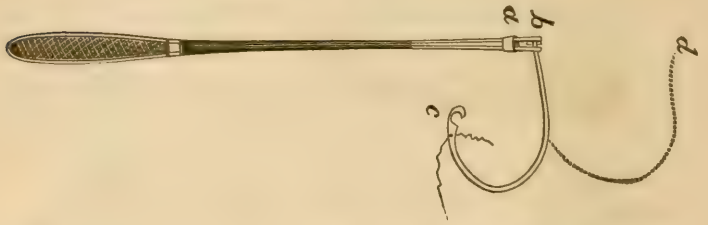
chain-saw, such as Prince's modification of Chassaignac's instrument (Fig. 103), or the instrument contrived for the

Fig. 103.



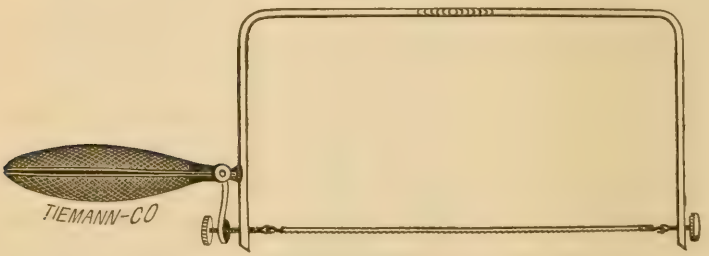
same purpose by Post (Fig. 104); a Symanowsky saw

Fig. 104.



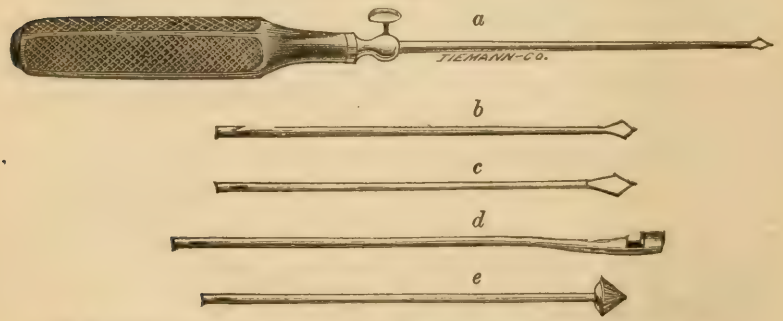
(Fig. 105), which may be readily removed from the frame

Fig. 105.



and passed underneath the bone, and, being readjusted, it may be made to cut in any direction, even in the segment

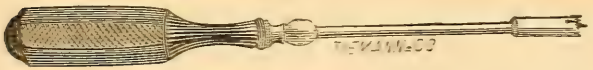
Fig. 106.



of a circle; the bone-drills (Fig. 106) of Brainard, *a*, *b*, *c*, of Parker, *d*, of Isaacs, *e*; the small trephine of Pope,

(Fig. 107); or the drills worked by a bow, recently invented by Howard, U.S.V.

Fig. 107.



In addition, the surgeon ought to have at hand cauterizing irons; iron, lead, silver, or zinc wire.

EXSECTIONS OF THE UPPER EXTREMITIES.

Exsections performed upon the upper extremities, whether in the continuity or contiguity, have presented results highly satisfactory and encouraging. It must not be forgotten, however, that the results of amputations in the upper extremities contrast favorably with the results of amputations in the lower extremities; and that efforts to save these limbs when terribly mutilated, without even resorting to exsection, have in very many cases met with remarkable success.

PHALANGES OF THE FINGERS.

In the case of these small bones, experience has shown that, under some circumstances, exsection of the entire phalanx has been followed by the reproduction of the bone.

Similar results have occasionally been obtained in the case of certain other bones.

The condition requisite to success in the case of the phalanges is, that the whole, or nearly the whole, of the periosteum should remain after the bone is removed. We do not think the integrity of the periosteum can be sufficiently preserved by a dissection made by the knife, and that it is only where, as in a case of onychia osteosa, or bone felon, the separation has taken place by the interposition of the

process of suppuration, that an entire phalanx will ever be reproduced.

In the May number of the *Buffalo Medical Journal*, for 1850, we published the following case:—

"Catherine Dolen, aged 24; admitted to the Buffalo Hospital of the Sisters of Charity, Dec. 25th, 1849, with onychia osteosa of the last phalanx of the thumb. The bone was necrosed, and on the 29th I removed it entire. The inflammation having considerably subsided, on the fifth day I applied a tape roller the whole length of the thumb and moderately tight. This was continued with occasional intermissions during two months, when a new phalanx was found to have been formed, of nearly the same length and breadth and form as the original phalanx; the articulating surface was also re-formed, and the flexor and extensor tendons so attached as that the motions of the joint were perfect."

This is the first example of successful reproduction of an entire phalanx which we have found upon record. We have been informed, however, that Dr. Dudley, of Lexington, Ky., had succeeded in a similar case before the date of this publication.

In the case of the last phalanx, when there is no external wound to determine the point of incision, the knife should be entered upon the palmar surface, so as to avoid injury to the root of the nail.

Exsections in the continuity of either the first or second phalanges, should be made with bone-cutters or with a very fine saw. When the character of the accident leaves the choice to the operator, the incisions should be made upon the dorsal surface, and to one side of the centre, taking care not to wound the extensor tendons. The ends of the fragments should then be brought into contact, as nearly as

possible, so as to insure bony union; the fingers being placed in a well fitted gutta-percha splint.

Exsections in the contiguity should leave undisturbed, if possible, the attachments of the tendons, the incisions being made on the posterior and lateral aspects; and passive motion should be early practised, in order to preserve the functions of the joint.

In removing an entire phalanx of the first or second row for necrosis—the incision being made upon the posterior and lateral aspect—the centre of the shaft should be first divided by the bone-cutters, and then the two articular extremities carefully dissected out.

Exsections of either of the metacarpo-phalangeal articulations require the same incisions as operations upon the phalangeal articulations, only that the joints being larger, the incisions must be more ample. In some cases we prefer a V-shaped incision. Great care must be taken not to injure either the flexor or extensor tendons.

METACARPAL BONES.

In the case of the thumb, the incision should be made upon the radio-dorsal margin, so as to avoid the extensors on the one hand, and flexors on the other. (Fig. 108.) The same point should be selected for an operation upon the metacarpal bone of the index finger; but in the case of the little finger the incision should be made upon the ulno-dorsal margin. In operations upon the metacarpal bones of the ring or large finger, the incisions may be made upon any part of the dorsal surface, but the tendons must be carefully laid aside.

When an entire metacarpal bone is to be removed, it must be first divided in its shaft by the chain-saw or bone-cutters. It is often found difficult, in the case of the third

and fourth metacarpal bones, to pass the chain-saw, and the bone-cutters will then have the preference. (Figs. 109, 110.)

Fig. 108.

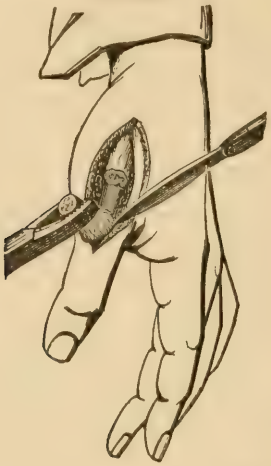


Fig. 109.

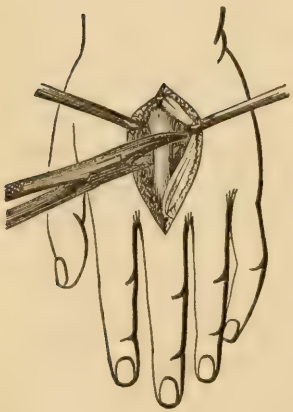
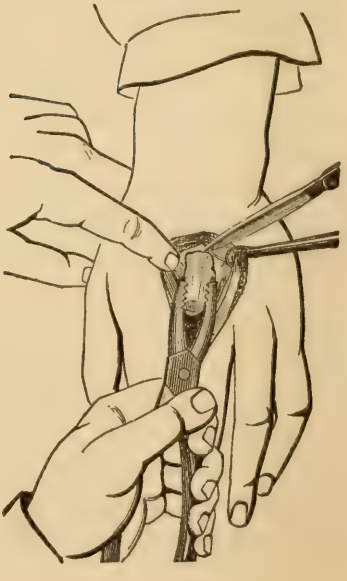


Fig. 110.



CARPAL BONES.

In cases of caries, one or more of these bones have been removed, leaving a useful wrist and hand. In some cases all have been removed at the same time. Similar operations are frequently practised in recent gunshot injuries.

The incisions must be made from the dorsal or lateral surfaces, and their form and direction may be varied according to circumstances.

In the removal of single bones the attachments of tendons may be generally respected; but in the removal of several, or of the entire mass, it is better to divide the extensor tendons rather than subject them to the injury which the removal of the bones is pretty certain to inflict. We ought to save the tendons passing to the thumb if possible.

When several bones are excised in the same operation, it is often most convenient to detach one at a time.

The relations of the radial and ulnar arteries to these bones, upon the outer and inner margins of the palmar surface of the wrist, must not be forgotten.

FORE-ARM.

Both the radius and ulna when necrosed have been removed singly, and useful arms have been preserved; the incisions being made upon the whole length of the radio-dorsal margin in the case of the radius, and upon the ulno-dorsal margin in the case of the ulna.

In making an operation of this kind, the brachial artery should be compressed by an assistant; and the first incisions having been made, the bones should be divided in their shafts by a chain-saw before disarticulation is attempted.

Exsection of a portion of the shaft of one or the other of these bones, for necrosis or other diseases, is often required;

but in a case of gunshot injury, or of comminution of both bones from any other cause, it must be understood that while on the one hand, if the arm is saved and the fragments unite, the arm will certainly be deformed and somewhat maimed; on the other hand, if a considerable portion of the length of the two bones is lost, there will be great danger that no union will ever take place, in which event the arm will be of but little value.

We ought to adopt it as a maxim, therefore, not to remove any fragments except those which are very small and pointed, and near the surface, or which, lying more deeply, are almost completely detached, and whose death we can certainly foresee.

Sharp points may be cut away, and all the fragments must be put into position as well as possible; the limb being then laid in that position which is most likely to insure union.

If, however, it becomes a question between amputation and exsection, then, as a general rule, we might prefer the latter; because a useful arm may result; and if it turns out otherwise, amputation still remains as a final resort.

In case but one bone is broken, then exsection, even to a limited extent, of the entire thickness of the shaft, will insure non-union. We have seen more than one illustration of this unfortunate result, when a portion of the radius or of the ulna having been removed while the parallel bone remained entire, no union has taken place, and the limbs were much more seriously maimed than they would have been had the fragments united with deformity.

At the wrist-joint, if a ball traverses the articulation from before back, or in its shortest diameter, exsection is not generally demanded; that is to say, a better limb is generally obtained by removing only the small and loose fragments than by excising the lower ends of the radius and

ulna; which latter operation can hardly be made without the section, or serious disturbance and injury of tendons and other important structures.

If, also, only the articulating extremity of the radius is injured, the surgeon must bear in mind that its removal will deflect the hand strongly to that side, and it ought, therefore, if possible, to be saved; and if it must be cut away, it will be better to exsect the corresponding portion of the ulna also.

The same remarks will not apply equally to the removal of the lower end of the ulna. It may be exsected alone without causing any deflection of the hand.

If the ball has traversed the lower ends of both bones from side to side, complete exsection will often constitute a valuable substitute for amputation. The bones in this case ought to be removed, as nearly as possible, at the same point; and we need not hesitate to apply the saw well up from the joint to the extent of one or two inches, since a shortening of the limb is here of little consequence, and the higher the bones are removed, the more complete will be the relaxation of the muscles, and consequently the less active will be the inflammation and the suppuration.

In a former treatise we have fully explained the value of this muscular relaxation, as accomplished by exsection in this and other joints of the body after compound dislocations; and we have cited cases from our own practice and from the practice of other surgeons, in support of these views.*

ELBOW-JOINT.

Exsections of the elbow-joint, either in part or in its totality, have been practised to a great extent during the last

* Treatise on Fractures and Dislocations. Article, Compound Dislocations of Long Bones.

few years, and with the most encouraging results. Both in cases of caries or necrosis, and in comminuted fractures involving the joint, it constitutes a valuable substitute for amputation.

The operation in itself is always sufficiently simple, and may be practised by any surgeon who is competent to make an amputation; it does not necessarily involve the destruction of a single important nerve or bloodvessel, and in some instances the attachments of very few muscles are lost, while it frequently happens that the arm is subsequently nearly as useful as it was before.

It will not be supposed that all gunshot injuries of this joint demand either amputation or exsection. If only the posterior or lateral portions of the articulations are laid open, and the bones are only slightly broken, the arm is often saved without any operation. If the comminution is extensive, and at the same time the brachial artery is wounded, or both the median and ulnar nerves are torn, then amputation is the only proper resort. If, while extensive comminution exists, there is no injury to the artery, or to more than one of the principal nerves, then exsection is to be preferred.

The operation may require the removal of one or of all the articular surfaces.

The incisions must be made from the posterior or lateral aspects of the joint, and will vary in form, and more or less in situation, according to the nature and extent of the injury.

In case the surgeon desires to remove all the articulating surfaces, and is permitted a choice of incisions, we think he will find the double, quadrilateral flaps, or incisions made in the form of the letter H, the most convenient. The flaps are formed by two vertical, lateral incisions, extending

from above downwards across the most prominent points of the internal and external condyles, these incisions being united near their centres by a horizontal line which traverses the middle of the olecranon process.

The two flaps, thus formed, being dissected upwards and downwards, expose all the parts to which the saw is to be applied. The upper flap includes the lower end of the triceps, severed from its attachments to the olecranon process.

The humerus being laid bare as high as it is thought necessary to make the section, the chain-saw is passed and the section completed; after which the divided end is turned down—the elbow being meanwhile bent at a right angle—and the disarticulation effected by cutting from its anterior towards its posterior surface. During the latter part of this process the surgeon must take care not to wound the ulnar nerve, lying near the inner side of the bone, and just behind the inner condyle, nor the brachial artery in front at the bend of the arm.

The next step consists in exposing the button-like head of the radius, cutting its lateral and orbicular ligaments, and dividing it with a chain-saw, if possible above the insertion of the biceps.

Finally, the operation is completed by passing the chain-saw underneath the ulna, if the section is to be made below the coronoid process; or if the olecranon process only is to be removed, the section will be made more easily by a common saw assisted by the bone-cutters or the mallet and chisel. It is desirable always to remove nothing more than the olecranon process, or at least to make the section of the bone above the insertion of the brachialis anticus, in order to preserve the power of flexion. The brachialis anticus has its insertion upon the base of the coronoid process, and

not upon the apex or summit, as some surgeons and anatomists have incorrectly stated.

Before separating the ulna the surgeon must look again to the safety of the ulnar nerve. A case which has recently come under our observation, however, suggests the propriety of dividing this nerve when it has already suffered much injury. A man having been submitted to exsection at this joint, has suffered greatly for many months from pain in the course of the ulnar nerve; his fingers have gradually contracted, and his arm is becoming paralyzed and atrophied. It is now decided that amputation alone will give him relief. However much care one may exercise in separating and drawing aside this nerve, it will necessarily receive some harm, even from the exposure; but it is most often seriously injured by the accident itself, its position rendering it peculiarly liable to laceration or contusion when the lower end of the humerus is broken. Granger first called attention, in the Edinburgh Medical and Surgical Journal, to the frequency of this lesion after fractures of the internal epicondyle, and we have seen the same thing happen occasionally. In our treatise on Fractures and Dislocations, we have reported a case of fracture at the base of the condyles in which pressure upon the ulnar nerve (incorrectly stated as the median) occasioned great suffering and deformity, and in which we resorted without success to exsection of the projecting bone.

Acting under these impressions, in a case of exsection at the elbow-joint recently made at the Bellevue Hospital, finding the nerve exceedingly painful, and believing it to have suffered a violent contusion, we severed it as soon as it was fully exposed. The pain at once ceased, and the case is now progressing satisfactorily.

HUMERUS.

Removal of portions of the shaft of the humerus for gunshot injuries is occasionally rendered necessary; but the remarks which have been made when speaking of exsection of the shafts of the radius and ulna must be repeated here—the removal of any considerable portion is liable to result in non-union; and it is generally better to hazard a tedious recovery, with a crooked and deformed union, than to hazard the occurrence of a false joint.

Latterly, in order to avoid this evil, the practice has been adopted by some of our surgeons of wiring the bones together after their section has been completed; employing for this purpose a drill to perforate the ends of the bone, and a strong piece of annealed iron, silver, or zinc wire to hold the fragments together. We have practised this expedient in cases of exsection, upon the tibia and ulna with success; we were able thus to maintain absolute contact and secure bony union. In one instance, also, having trephined the angle of the lower jaw in order to practise exsection of the inferior maxillary nerve, the jaw was accidentally broken entirely across while removing the trephine. We proceeded immediately to perforate the opposite ends of the fragments with a common awl, and secured them in place with a silver wire. The fragments united very promptly and without displacement; the wire suture also came away spontaneously in a few weeks, having apparently cut its way out through the bone. This will not generally happen, however; and after the union is effected, the wire should be cut and removed.

SHOULDER-JOINT.

The anatomy of this region has been given under "amputations" at the shoulder-joint.

In no other portion of the bony skeleton have exsections been attended with such favorable results. The joint is so simple and accessible, and its exposure demands so little dissection of muscular and other tissues, that only a moderate shock is communicated by the operation to the system. The great majority therefore recover, and with very useful limbs.

If practicable, the operation ought to be made by a single longitudinal incision, so as to avoid as far as possible the section of muscles; this incision may commence close upon the acromion process in front, and extend downwards in the direction of the fibres of the deltoid muscle, as far as shall be deemed necessary. The long head of the biceps may now be drawn aside, or if it seems to be required, it may be severed, the insertions of the rotator muscles divided, the capsule opened, and the head of the bone disarticulated. Section of the bone may be accomplished with a common saw in most cases. If the bone is divided before the head has been disarticulated (Fig. 111), the chain

Fig. 111.

saw will be required, and the order of dissection will be changed, as the wood-cut will sufficiently explain.

The above described methods are especially applicable to exsection practised for caries or necrosis of the head of the humerus.

In gunshot or other comminuted fractures of the head of the humerus, demanding exsection, the surgeon will find it necessary, in general, to make for himself a larger opening than the single longitudinal incision will furnish.

It will be necessary then to make an oval (Fig. 112) or a V shaped (Fig. 113) incision, so as to form a flap, having

Fig. 112.

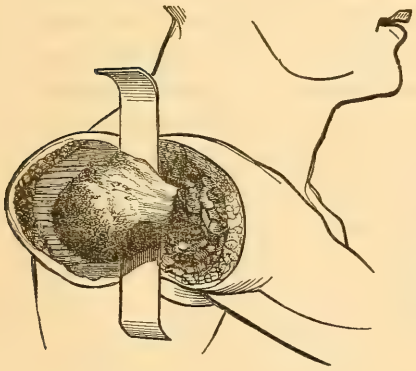


Fig. 113.

its base upwards. By these methods we divide more or less completely the deltoid muscle, and the utility of the arm is thereby measurably diminished, but not to the extent which we might have anticipated.

Having elevated the flap and exposed the bone, the surgeon proceeds to remove the broken and loose fragments, including the head of the bone; the latter being disarticulated by dissections made from below upwards, or from above downwards, as may be found most convenient.

In all cases the surgeon will preserve, if possible, the

attachments of the long heads of the biceps and triceps, which are inserted respectively into the upper and lower margins of the glenoid cavity. He will also remove as little of the shaft as possible, desiring especially to preserve all the insertions below the surgical neck.

The upper end of the lower fragments, if sharp-pointed, must be cut off with the saw or bone-cutters before the operation is completed.

At Fredericksburg, in May last, while the battles of the "Wilderness" were in progress, we saw several of these exsections of the head of the humerus which had been made upon the field, to most of which were applied long arm-splints, and sometimes right-angled splints extending along the fore-arm as well as arm, and secured in position by rollers. These dressings were all loose, saturated with pus, and generally covered with maggots; while at the same time they were of no possible use.

It is much better to close these wounds with adhesive plasters, dress them with cool water lotions, and leave them in all other respects unsupported and uncovered, only sustaining the fore-arm by a sling. Rather than crowd the lower fragment upwards towards the shoulder-joint for the first few days, it is better to permit it to fall easily downwards; and for this purpose the sling should pass under the wrist, and not under the elbow-joint. If the elbow is much lifted the upper end of the bone is liable to be tilted and thrust against the flesh.

CLAVICLE.

The clavicle is often extensively comminuted in gunshot injuries, and occasionally some of the smaller fragments will require removal. In a very few instances actual exsection of the broken and projecting extremities has to be practised

It is remarkable, however, how speedily this bone generally unites, even when it is extensively broken; and it is equally a matter of observation that, although the union may take place with a good deal of deformity, the functions of the arm are not seriously if at all impaired.

If exsection is practised upon a recent injury and a considerable amount of bone is removed, sufficient to prevent the fragments from coming easily into contact, the separated ends should be maintained in contact by wire; the arm being afterwards supported by a simple sling.

The removal of necrosed fragments of the clavicle is sometimes followed by a rapid reproduction of the lost portions. We have mentioned in our treatise on Fractures and Dislocations a remarkable case of this kind reported by Dr. Ayres, of Brooklyn, N. Y.

We have seen several examples of ligamentous union after gunshot fractures, but in which the value of the arm was but slightly impaired. One of these was reported in the *American Medical Times*, in 1863, by Frank H. Hamilton, Jr.

SCAPULA.

Fragments of the scapula having been completely detached by the force of the bullet, or becoming subsequently necrosed, frequently require removal in military practice; but it is seldom that actual exsection of any portion of this bone is demanded; and in case exsection of a portion or of the whole of the scapula is rendered necessary, we do not think the surgeon would be aided in the performance of his operation by any suggestions or anatomical descriptions which could here be given.

EXSECTION OF THE LOWER EXTREMITIES.

We have already had occasion to notice that the upper

extremities contrast remarkably with the lower in their ability to sustain severe injuries. The upper extremities may often be saved, and their functions measurably restored, without much surgical interference; when, under the same circumstances, the lower extremities would be lost or even life would be sacrificed. In the one case, also, amputation presents a fair average of successful results, while in the other the results are anything but encouraging. We are now compelled to make the reluctant confession, that exsections applied to the lower extremities present the same unfavorable antagonisms; comparatively speaking, only a few of these latter operations are successful; nor does the saving of the limb by exsection, in general, to the same extent restore its functions.

It is nevertheless true that, as compared with attempts to save the limb without any operation, and as compared with amputations, the results of exsection have thus far proved sufficiently satisfactory in many cases to warrant the continuance of the practice.

PHALANGES OF THE TOES, AND THE METATARSAL BONES.

The remarks which have been made upon exsections of the fingers, and upon amputations of the metacarpal bones by disarticulation, etc., will render unnecessary a more special consideration of exsections of the toes or of the metatarsal bones.

The results of these latter operations have generally been successful. It must be remarked, however, that separation of metatarsal bones at their tarso-metatarsal articulations, involves always the danger of the extension of inflammation along the synovial membranes to the adjacent tarsal bones; and in some instances we have seen exfoliation of one or more of the cuneiform bones ensue.

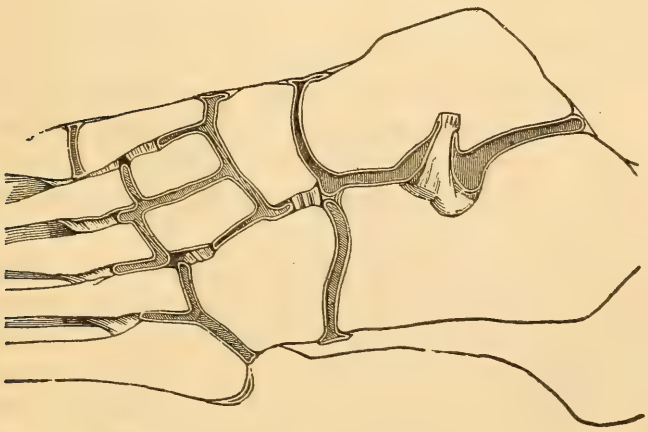
We have recently had under our care a distinguished physician of Boston, Dr. John Flint, whose case illustrates this danger. Having received accidentally a wound from a rifle-ball, the ball having penetrated and comminuted the metatarsal bones, an attempt was made by exsection to save the foot. In a few weeks, however, the inflammation and suppuration were found to have extended from the synovial surfaces at the tarso-metatarsal articulations to the tarsal bones, involving these latter so completely as to render amputation of the foot necessary.

TARSAL BONES.

Surgeons have frequently practised, in cases of caries, necrosis, compound dislocations, and compound comminuted fractures, the exsection of one or more of these bones; so that there is no single bone of the tarsus which has not at one time or another been successfully removed.

According to our own experience, however, the results

Fig. 114



of these operations have seldom been wholly satisfactory. As will be seen by the accompanying illustration (Fig. 114),

the synovial sac or sacs which belong to one bone are frequently prolonged into the spaces between other bones; so that the inflammation and suppuration consequent upon the removal of one bone are exceedingly prone to invade, and thus as it were enucleate others. The astragalus is the only one of them all which can be said to have a synovial sac appropriately its own; but a removal of the calcaneum endangers the astragalus; removal of the naviculare endangers all the bones which lie in juxtaposition; removal of either of the cuneiform endangers the remaining cuneiform; and removal of the cuboid endangers all of the cuneiform.

In addition to the peculiar anatomical character of the synovial sacs, we must enumerate as active causes in the propagation of inflammation, and in the production of caries and necrosis after partial exsections, the great abundance of fibrous tissue upon all sides, and the spongy nature of the bones themselves.

Moreover, the tarsal bones constitute a large portion of that important arch upon which the entire bony superstructure rests. The several portions of which it is composed are all alike essential to its perfection, and the removal of any single bone necessarily gives a certain degree of instability to the gait. What, therefore, might be regarded as a success in any other portion of the body, must often be regarded as a failure here.

We have no evidence that the operation is in general any more safe than amputation at the ankle-joint, and with few exceptions, we think, the latter ought to be preferred, as furnishing, when the cure is completed, a more useful limb.

The exceptional cases in which we would recommend exsection, are certain examples of necrosis in which the

progress of suppuration has already more or less completely enucleated the bone, and a few examples of compound dislocation or of compound fracture, when the bones are with facility removed, and the integrity of the remaining bones can be placed beyond question.

As to the method of operating, no rules of universal, or of even general application, can be given. Care must be taken while exsecting one bone not to disturb the connections of another, and beyond this the surgeon will proceed according to his own judgment.

ANKLE-JOINT.

Among the earliest operations of exsection were those practised at the ankle-joint for compound dislocations of the tibia and fibula. We have in several instances resorted to this expedient successfully in similar cases, and in our published report of some of these examples we have called especial attention to its value and importance.

In certain gunshot injuries of the lower ends of the tibia and fibula, exsection is equally applicable: as, for example, where a ball has traversed the lower ends of one or both bones, without having injured the bones of the tarsus, or the principal bloodvessels and nerves.

In case the lower end of the tibia alone is involved, its exsection renders necessary the removal, to the same extent, of the fibula also. If this is not done, great deformity and instability will result.

If, at the same time that the lower end of the tibia is comminuted, the fibula is broken but not much or at all comminuted, exsection of the tibia may be practised without interfering with the fibula, inasmuch as the latter, being broken, will shorten upon itself.

The lower end of the tibia must be sawn off square.

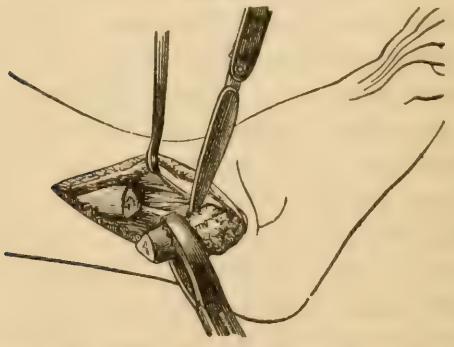
We may not here, as in the arm, leave a pointed fragment, for the reason that the weight of the body is to be borne by this extremity.

If the portion of tibia to be removed equals or exceeds four inches, amputation ought to be preferred, since an artificial foot would furnish a more useful means of progression than a limb shortened to this extent. In case the bone is removed for necrosis, and the periosteum is saved, this rule will not apply. More or less of the lost bone is likely to be reproduced.

If the fibula alone is involved, exsection may be practised to any extent without interference with the tibia being demanded.

In the removal of either bone, when the choice of incision is left to the operator, he will choose the inner aspect of the limb for the tibia and the outer aspect for the fibula; and if the continuity of the bones is not already completely interrupted, he will divide the bones with a saw, or a chisel and mallet, and then proceed to disarticulate. (Fig. 115.)

Fig. 115.



When the operation is completed the limb should be placed in a box, well supported; but no portion of the

limb should be subjected to great restraint or to ligation from adhesive plasters, bandages, or splints.

At the earliest practicable moment, passive motion should be employed, so as to secure the formation of a new joint. The joints thus formed are composed almost entirely of fibrous bands, which occupy the space between the extremities of the bones of the leg and the astragalus. These bands, in case passive motion was not employed, would contract and prevent motion altogether; but if stretched daily they become elongated, and finally allow great freedom of motion.

SHAFTS OF THE TIBIA AND FIBULA.

In cases of necrosis we frequently practise the removal of more or less of the shaft of the tibia, and in one instance we have had occasion to remove the entire shaft; after which the bone is in general sufficiently reproduced to give the requisite stability to the limb.

Exsection of this bone in its continuity, after gunshot injuries, has been followed by much less favorable results. It has often been found proper to remove a few splinters or small spicula; but whenever any considerable portion of the entire thickness of the shaft is removed, the fibula remaining sound, so that the opposite ends do not remain in actual contact, no bony union takes place, and a false joint is the result. If, therefore, the successful treatment of the case plainly demands extensive exsection, or even extensive removal of loose fragments, it will be better to amputate. If the fibula is broken also, permitting the limb to shorten upon itself, bony union of the tibia, after its exsection, may take place. It is true, however, that even under these circumstances it is apt to fail. Perhaps better results may be obtained from the practice of wiring toge-

ther the ends of the tibia. Some of our army surgeons have adopted this method recently, but with what success we are not informed.

When the fibula alone is comminuted, exsection may be practised to any extent without essentially impairing the usefulness of the limb; yet one will seldom find occasion to exsect any portion of this bone immediately after gunshot injuries, although it may often be found judicious to remove a few loose fragments.

KNEE-JOINT.

This is a perfect ginglymoid articulation, and is supported by its capsule, the ligamentum patellæ, lateral, posterior, and inter-osseous ligaments; the latter, called crucial, are situated near the middle of the joint surfaces, but nearer the posterior than the anterior part of the joint.

The articulation is reinforced by several tendons and muscles which traverse it on its lateral and posterior surfaces.

Posteriorly, in the ham of the leg is found the popliteal artery, vein and nerves, and in the same relative order in which they have been enumerated; the artery lying nearest the bone, very close upon the posterior ligaments of the joint, the vein more superficial, and the popliteal nerves much nearer the surface.

The superior and inferior articular branches, arising from the popliteal and passing around the limb above and below the joint, are the only arteries requiring ligature which are necessarily wounded in the operations of exsection at this joint; and when only a small portion of the extremities of the bones are excised, these may often be avoided.

No surgical operation can be more simple than the exsection of the knee-joint, so far as its mechanical execution alone is concerned. It can be accomplished also with the

loss of only a few drops of blood; yet up to this moment the operation is more in debate, and its advantages are more questionable than any other exsection hitherto made.

The disadvantages under which the operation labors are apparent.

Operations have been shown to be more dangerous in the lower than in the upper extremities; and also more dangerous when made near than when made remote from the body. Excision of the knee unites in itself both of these extra hazards. Moreover, the knee is the largest joint in the body, and its exsection exposes a broader surface of bone to inflammation, suppuration, and its accidents, than any other.

The results of the operation, if successful, are less favorable, because while in the case of every other exsection of a joint we are able to substitute a new and tolerably useful joint, here, experience has shown, we must substitute anchylosis for the original joint; we must convert the thigh and leg into one long, awkward, unwieldy lever, and that, too, not of the same length as the other limb. Its value, therefore, in comparison with an artificial limb, for the purposes of progression, is still a matter of doubt. In ascending or descending an acclivity it is particularly inconvenient; and even in the sitting posture it becomes an annoyance to others, if it is not to its possessor.

Notwithstanding all these disadvantages, the operation still retains the confidence and approval of some of our most experienced surgeons, especially as applied to ulceration of the synovial and cartilaginous surfaces of the bones. In its application to gunshot injuries, it has always found fewer and less enthusiastic advocates.

The following example we believe to be the only successful case of excision of the knee-joint, made for gunshot

injuries, ever yet placed upon record. The operation was made by R. B. Bontecue, Surgeon, U.S.V.; and for this brief history we are indebted to Dr. I. W. Lyon, House-Surgeon to Bellevue Hospital, who is engaged in preparing an elaborate paper on Exsections.

A man, aged twenty, was wounded in the right knee, October 22d, 1862. The ball passed through a portion of the external condyle of the femur and lodged in the popliteal space. On the second day after the injury, Dr. Bontecue removed one and a half inches of the lower end of the femur with a saw; and with a pair of bone-forceps cut away the articular surface of the tibia, until the bone was exposed. The patella was dissected out. A portion of the wound healed by first intention. On the twenty-eighth day the wound had entirely closed; and at the end of a little more than two months from the date of the operation the patient was discharged. There was then "no pain or tenderness about the joint."

Several other exsections at this joint have been made by our army surgeons for gunshot injuries, but, so far as we are informed, no other cases have been successful.

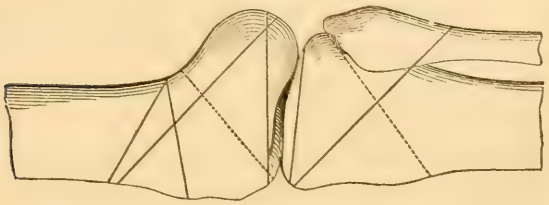
In order to success, certain conditions are requisite, which in military practice are seldom united. The comminution must not much, if at all, extend beyond the epiphyses. The operation ought to be made early, before the accession of inflammation or congestion; and after the operation is made the patient must remain at rest, and receive the best possible care and attention for several successive weeks. Says Guthrie: "It is, nevertheless, an operation which ought not to be done on the field of battle, unless perfect quiescence and every desired accommodation can be obtained, and no endemic disease prevails."

In case it is ever deemed proper to operate, the method

which we would recommend is as follows: Two parallel incisions are made, one on each side of the knee, near the anterior margins of the lateral ligaments, of about six inches in length. These two are joined by a transverse incision which crosses the front of the knee upon the lower margin of the patella. We have thus formed lines of incision describing the letter H, and two quadrilateral flaps. The leg being bent at a right angle with the femur, the ligamentum patellæ, capsule, lateral ligaments, and crucial, are successively divided.

An examination of the knee-joint ought now to be made, in order to determine upon the form and amount of exsection; the surgeon being governed in these points only by the character and extent of the lesions: he will, however, take care that the exsections of the femur and the leg are so made, as that when the surfaces of bone are brought together, the limb will remain very slightly flexed at the knee-joint, a perfectly straight limb not being found so convenient for progression as one flexed at an angle of five or ten degrees. In the following diagram are represented some of the various forms of exsection of the bones which it may be found necessary to adopt. (Fig. 116.)

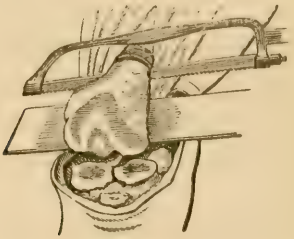
Fig. 116.



In dividing the bone a common saw may be employed, the soft parts on the sides and behind the bone being pro-

tected from injury by a stout piece of cloth drawn snugly around and behind the part to be removed. (Fig. 117.)

Fig. 117.



As soon as the section is completed the surgeon will place the ends in contact, to ascertain whether the limb will occupy the proper position. If the angle at the knee is too great or too small, he will proceed at once to correct the error by the removal of another section.

In case only a small portion of the extremity of each bone has been excised, the patella may now be dissected out, the bones brought together, and the incisions closed; but if a large portion of one or both bones has been excised, the knife will be again carried across the knee at the upper margin of the patella, so as to shorten the upper flap and at the same time remove the patella. Whatever method of operating is adopted, the patella ought to be removed; experience having fully shown that its presence generally protracts, and sometimes actually defeats the cure.

Such of the articular arteries as have been wounded being tied, and the bones having been securely wired together at two or three points, the integuments are closed with light and short adhesive straps, aided, perhaps, by three or four sutures, and the limb is laid in a long, well fitted, and

well padded box or splint. The box may be made of zinc or tin, and supplied with floating sides opposite the knee, to enable the surgeon to dress the wound from time to time without disturbing the limb.

SHAFT OF THE FEMUR.

The removal of certain loose fragments of bone after gunshot injuries of the femur has already received our qualified approval; this approval does not extend, however, to the removal of either large or small fragments, which have any considerable attachment to the periosteum.

Exsection properly so called, or the actual separation by the saw, or by other means, of sections of the bone, in cases of recent or old gunshot injuries, for the purpose of removing all fragments and projecting points, and making of the whole a clean wound, has thus far during the present war proved eminently unsuccessful. We know of but few instances in which the attempt has not been followed by a loss of life. We are informed that of fourteen exsections of the shaft of the femur made in one hospital after the battle of Williamsburg, all terminated fatally. We believe these were all secondary operations; but no better success, so far as we are informed, has usually followed primary operations.

Dr. Clarke, surgeon to the 8th Mo. Cavalry, reports in the *Chicago Medical Times*, for June, 1863, four successful cases by this method, and he thinks the practice ought generally to be adopted in similar cases. We cannot agree with the writer. Indeed we must say candidly that we have never seen a case which would justify the operation.

The great depth of the bone and the attachment of the

muscles to almost every point of the surface of the bone, are perhaps the chief circumstances which render these operations so unsuccessful.

HIP-JOINT.

The anatomy of this joint has already been sufficiently described when speaking of amputations at the same point.

The value of exsection in certain cases of necrosis and caries at the hip-joint is no longer a subject of debate; nor do we think that any reasonable doubt can be entertained of its value and of its advantages over amputation in certain cases of gunshot injuries of the neck of the femur and of the trochanters. In case the ball has entered the head of the femur, it is scarcely possible that the acetabulum has not suffered some lesion also, and the chance of success by exsection must be greatly lessened.

In cases of necrosis and caries of the head of the femur, occurring in scrofulous patients, the muscular tissues are usually greatly atrophied, and the integuments adhere so closely to the diseased structures that the incisions are seldom required to be either deep or extensive; but exsections made for recent gunshot injuries in persons of ordinary health and condition, demand deep and broad incisions, and must be regarded as operations of much greater magnitude.

The mode of incision may be varied very much, according to the fancy of the operator and the circumstances of the case.

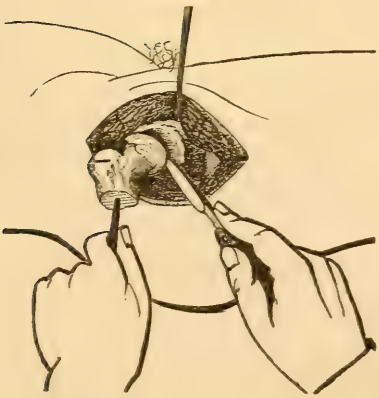
If the neck of the thigh bone is already severed by the ball, the operator will direct his knife first towards this part and complete the operation by disarticulation.

Some surgeons, Chassaignac for example, prefer in all

cases to divide the neck with a chain-saw before disarticulating the head, as the reader will see illustrated in the two following wood cuts (Figs. 118, 119).

Fig. 118.

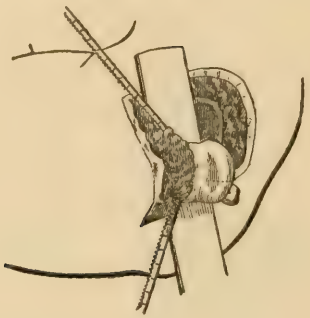
Fig. 119.



Most operators, however, have preferred, whenever it is practicable, to disarticulate before making the section of the

bone (Fig. 120). In either case the primary incisions would be the same.

Fig. 120.



The method recommended by Mr. Fergusson will in general be found most convenient:

"The body being placed a little to one side so as to elevate the hip, an incision with a strong bistoury should be carried in a semilunar course about two or three inches above the trochanter, its ends being so limited as not to interfere with the crural nerve in front, or the gluteal artery behind: from the centre of the concavity thus formed, a straight line of incision should be carried downwards over the trochanter, the two being each of a length proportioned to the bulk and depth of the parts. The knife should be carried deep, and one flap should be turned forwards and another backwards, so as to expose the upper part of the trochanter, neck of the bone, and capsular ligament —the three glutei, more especially the medius and minimus, being freely cut for the purpose. The capsule should next be opened on its upper aspect, when by twisting the thigh across its fellow, and rotating it outwards at the same time, the head of the bone will start from its socket: if the round ligament remains entire, which it probably will, unless considerable force is used, it can be touched with a knife, and the articular surface of the femur will now be thoroughly exposed."

A case of successful exsection of the upper end of the

femur, is reported by David P. Smith, Surgeon U.S.V., in charge of General Hospital, Fairfax Seminary, Va., June 26, 1863:

"Joseph Brown, Co. I, 3d Michigan, was shot through the left great trochanter on the 29th August, 1862, at the second battle of Bull Run. He lay three days on the field, was then taken to Centreville, and finally brought to Fairfax Seminary General Hospital, Va., on the 11th of September.

"It being deemed best to attempt to save the limb, he was treated in obedience to that view, the limb being placed in a suitable splint, and as much nourishment being got down as possible. I twice removed fragments of dead bone from both the wound of entrance and exit, and his improvement was so great that about the end of February he began to think of going home. Early in March, however, the limb began to swell immoderately, he lost his appetite, his pulse became small and frequent, and the discharge from the wound, although scanty, became extremely fœtid. Under these circumstances I deemed it best to attempt relief by operation. Accordingly, on the 21st of March, having first made a large exploratory incision, and discovered much disease, I extended it at both ends, so that it reached from about three inches above the trochanter down on the outside, and along the axis of the limb, for about eight inches. So much new bone had been deposited about the seat of the fracture that, on beginning to dissect up the soft tissues from the tip of the great trochanter downwards, much embarrassment was experienced from the greatly increased diameter of the bone. By the handle of the knife, and the fingers, the new bone and periosteum producing it was peeled off and pried away from the necrosed portions. Just below the trochanter the bone was but loosely agglomerated, and came away in large fragments in the grasp of forceps. With large and powerful cutting forceps the femur was squarely divided at from five to six inches below the tip of the trochanter major. A screw driven into the softened pudding-stone (bone) failed to hold, and the part to be excised was manageable only with necrosis forceps. The neck was found so much diseased that I proceeded to remove the head from the acetabulum, which was happily accomplished with but very trifling hæmorrhage.

"The portion excised will be sent to the Surg.-General's Office, furnishing, as it does, an impressive example of how much disease may exist after a gunshot wound, with but trifling manifestations of mischief, for, in this instance, nearly seven months.

"He was rallied with difficulty from the shock of the operation.

"After the lapse of about forty-eight hours an erysipelatous blush appeared over the whole thigh, and typhoid symptoms began to manifest themselves. I then pushed a female catheter into the wound, directing it towards the acetabulum. A jet of very offensive decomposing bloody serum issued through the catheter to the amount of four ounces. I retained the catheter in the wound, and introduced another one two or three inches below, so as to drain off all effusion; much serum and grumous blood poured out, oozing from the cut surfaces, and trickling through the catheters. On the fifth day after the operation he had a sever rigor, which gave rise to grave apprehensions, but the discharge through the catheters soon told that it was caused by hæmorrhage to the extent of four to six ounces. He soon rallied from this. I often washed out the cavity by injections of warm water and solutions of chloride of soda. The catheters often became clogged up, which as often necessitated their removal, cleansing, and re-introduction. For a day or two at first the limb lay on a pillow; I then applied Prof. N. R. Smith's anterior splint; but that, admirable in all other respects, preventing access to the front of the limb for the purpose of rubbing, I then contrived a species of hammock for the limb, hung from a beam overhead. The miniature hammock for the leg hung horizontally, but in order to effectually prevent any burrowing of pus, I hung it so high that the thigh was almost perpendicular. To support the thigh I passed a bit of soft towelling around the under surface of it, broad enough to extend from the perineum to the popliteal space, and suspended by cords leading back to an upright behind the bed at an angle of thirty-three degrees with the horizon. This latter support so equally pressed upon the under surface and two sides of the thigh, as to relieve the man immediately of all uneasiness, and cause a continual oozing from the wound and dropping from the catheters of pus, serum, and synovia. About seven days after the operation suppuration was fully established.

"An unlimited amount of nourishment was afforded this man from

the moment the nausea and vomiting induced by the chloroform had passed away. Ten or twelve eggs each day, with an unlimited amount of strong beef-tea, and half an ounce of brandy every two hours, were given him. In connexion with this case, I wish to remark, that my experience in all branches of the service has driven me to the conclusion, that it is not the fault of Government or of the Surgeon-General, if the sick and wounded in the army do not receive every comfort, every care, every attention. I must say that I have found that proper supplies, proper food, suitable clothing, and good nursing, are always obtainable by the surgeon for his sick and wounded. Careless and incompetent men will always probably exist, and contrive to creep into subordinate positions in every department, but the atmosphere for them in the medical corps of the army is so uncongenial that they soon drop or *are dropped* out. I make these remarks, because I have observed with pain the remarks of some surgeons who, from a want of experience, meeting with minor difficulties, and perhaps missing in the Supply Table some medicines used only by a few practitioners, think themselves justified in indulging in puerile complaints. Deeming it of the utmost importance that there should be, in the case of this man, no hindrance to digestion and assimilation that could be avoided, on the second day after the operation I discontinued the use of opium, which he had used nearly all of the time since his wound was received. This I did, of course, by rapidly diminishing the dose of the opiate, not dropping it at once.

"The above is an extract from my monthly report for the month of March. During April, Brown continued to improve. I gave him porter with large quantities of cod-liver oil part of the time, half a pint of the latter daily. I was obliged to keep in drainage tubes until the first of June. Whenever I removed them, as I did several times to try to do without them, pus would accumulate and burrow. When I removed the last one on the 1st of June, I passed a mesh of suture wire through the fistulous opening still remaining. This was retained until the 20th inst. The wounds, both of the operation and the original wound, are now entirely healed. The man is about on crutches. Of how much use this limb will be to him it is now too early to decide: I make no comments on the case, because I desire only to report its occurrence, and recommend the use of drainage tubes in all similar excisions, and indeed in all compound comminuted

gunshot fractures where there is much muscular tissue. Pus will not always readily flow even from most dependent wounds."

We have before us a letter from this man, dated at Coopersville, March 21, 1864, in which he speaks of himself as being in good health. He walks about and "attends to home business," "splits and saws a little wood," but complains of some pain in the leg and stiffness in the knee. On the whole, he says, there is a constant improvement, and he is exceedingly thankful for the service done him by his surgeon.

CHAPTER XX.

ARROW WOUNDS.

SECTION I.—GENERAL OBSERVATIONS. The author has had no experience in wounds of this class; but it was thought that an American treatise on Military Surgery could scarcely be regarded as complete which did not include at least a brief consideration of these accidents. There has been no period of our history as a nation in which our border territories have not been more or less subject to the warlike incursions of the Indians; and our armies have been almost constantly employed in the defence of feeble settlements, in the protection of emigrants while crossing the great plains and mountains to the Pacific coast, or in punishing and bringing into subjection hostile tribes.

Formerly, the weapons employed by these tribes were altogether the bow and arrow, the hatchet, and the scalping knife. At present the hatchet is much less used, and the bow and arrow have in a great measure been superseded by the rifle and musket. The arrow, however, in the hands of the Indian is no mean defence against the bullet of the white man. If it cannot be thrown as far, yet at certain distances it can be thrown with equal accuracy, and within a certain range it is not much less fatal. It possesses also one quality which in a forest warfare is of signal advantage —it strikes its victim silently, and thus gives no indication as to where the foe lies in ambush. The shooting of a sentinel gives no alarm to the sleeping garrison. For this rea-

son, and possibly because these were the weapons of their fathers, many of the more savage tribes still continue to use the bow and arrow.

Speaking of the fatality of wounds inflicted by arrows, says Surgeon Clements: "The idea which, I believe, prevails in civil life, that arrow wounds are trivial affairs, should be abandoned. It is the opinion of experienced line officers that in the hands of Indians the bow and arrow is, at the distance of fifty or sixty yards, a more effective weapon than the rifle, they being more expert in the use of the former." It is certain that among many of the native tribes a belief still exists that—

> "The white faith of history cannot show
> That e'er the musket yet could beat the bow."

We have availed ourselves, therefore, of the occasional writings of our intelligent army surgeons, and of such other facts as we could obtain from private communications, to compile a brief chapter on this subject. We are especially indebted to the very able paper on Arrow Wounds from the pen of J. H. Bill, Assistant-Surgeon U.S.A.,* and to B. A. Clements, Surgeon U.S.A. We shall make free use of both of these sources of information.

The use of the bow is of the earliest antiquity; and it has been, until the introduction of gunpowder, the most universal of all weapons. The Persians used bows made of a species of reed; the Lycians used for this purpose the cornell tree; the Ethiopians made them of the palm; the English and Scotch of yew, hazel, or ash.

This weapon was employed also by the Grecians and Romans, and in Europe it was in use until the introduction

* Notes on Arrow Wounds, by J. H. Bill, Assistant-Surgeon, U.S.A. Amer. Jour. Med. Sci., Oct. 1862.

of fire-arms. The English monarchs, down to a very recent period, took great pains to encourage the use of the long-bow; and during the reign of Henry VIII. a statute was passed commanding every father to provide a bow and two arrows for his son when he was seven years old. The bow is still employed by the natives of Asia and Africa, and in many other parts of the world, as well as by our North American Indians. Ballingall speaks particularly of arrow wounds as having been caused by an encounter of the British troops with the natives of one of the provinces of Ceylon in 1817; but of the character of these wounds, he adds, "we know comparatively little."* Larrey says he "had occasion to dress several soldiers of the ex-guards, who had been wounded in the battle of Eylau by the arrows of the Calmucs."† McClellan, in his report of his military commission to the U. S. Government, states that the bow and arrow is still retained in the Russian army for the purpose of picking off the sentinels without creating an alarm.

The bows employed by the North American Indians are usually from three to four feet in length, being more often four feet than three. They are constructed of some tough and elastic wood, such as the willow, ash, or hazel.

The arrow is composed of two parts, a shaft and a head.

The shaft is generally made from a branch of the dog-wood tree; a limb being selected which is about one-quarter of an inch in diameter. This is soaked in water, the bark peeled off, and then cut into the proper length; the length varying from two to three feet.

The method of straightening the shaft, as described by Bill, consists in fastening a small, flat piece of wood transversely upon the two extremities of the shaft; and while one

* Ballingall, Outlines of Military Surgery, fifth Edinburgh Ed. p. 392.

† Larrey's Observations on Wounds, etc. Amer. Ed. 1832, p. 29.

of the transverse pieces is held firmly in the mouth, the piece at the opposite extremity is grasped by the hand and "rotated to and fro after the manner of using a trephine;" in consequence of which the fibres of the wood assume a spiral form, and the shaft becomes gradually straightened. It often requires three days to complete a single shaft.

A notch is now filed in one end to receive the bowstring, and a slit made in the other to receive the stem of the head.

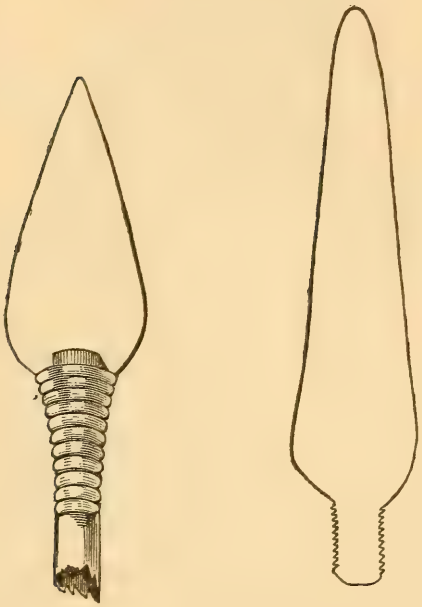
Before the introduction of iron by the white man, the material used in the construction of arrow-heads was generally a conchoidal chert, horn-stone, or common quartz; but at the present time most of the tribes use for this purpose soft hoop iron, which by the aid of a file they work into the form of an isosceles triangle, sometimes carefully sharpened, and at other times rough and often serrated on the edges, with a narrow neck or stem to be received into the shaft. The iron heads vary in length from half an inch to two inches, and in breadth from half an inch to three-quarters at their base. The stem is usually about one inch long by one-quarter of an inch in breadth, and serrated on its margins.

The head is made fast by thrusting its neck into the split extremity of the shaft, and binding it in place with a tendinous thong.

Occasionally the head and shaft are made of the same piece of wood, the head being much larger in diameter than the shaft, and pointed. These latter are used chiefly in sports and in hunting, but very rarely in battle.

The force with which these arrows may be thrown by good bowmen may be understood when it is known that they are frequently made to transfix completely the sides of a full grown buffalo.

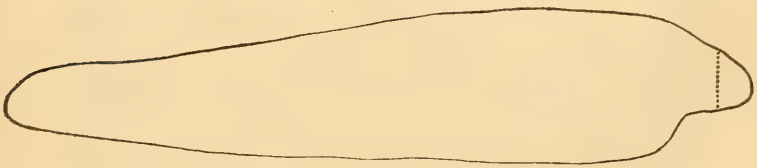
Fig. 121.



NABAHOE ARROW-HEADS, ACTUAL SIZE.

The following wood-cut (Fig. 122) represents in outline the actual size and shape of an arrow-head which Surgeon Clements found imbedded in the dense tissues about the tro-

Fig. 122.



OUTLINE OF ARROW-HEAD EXTRACTED BY SURGEON CLEMENTS, U.S.A. ACTUAL SIZE.

chanter major, and which he extracted. The head was four inches in length, and only about two or three lines of

the neck were projecting. The dotted line across the neck indicates the depth to which it was buried.

In another case the arrow-head struck with so much force one of the bones of the ilium that it had penetrated completely, and Surgeon Clements was required to exert his utmost strength several times with a pair of dentist's forceps before he could extricate it.

In a third case "an arrow entered just above the posterior fold of the axilla, and the shaft separated from the head with the exertion of the slightest force. Probing to the depth of two and a half inches gave no indication of the position of the head; and although," says Surgeon Clements, "I enlarged the wound to the greatest extent deemed justifiable, it could not be found. The man's arm was useless. After waiting three months, and in vain, in hope the arrow-head would give some positive indication of its position, I determined to endeavor to find it. There were reasons to suppose it had entered the axilla, but after making an extensive T incision, so directed as to enable me to search beneath the upper part of the scapula should it be found necessary, I was so fortunate as to find it sticking firmly in the bone at the base of the spine of the scapula, and bent twice upon itself, so forcibly had it been driven. It was removed with some effort, after being seized with a pair of strong forceps."

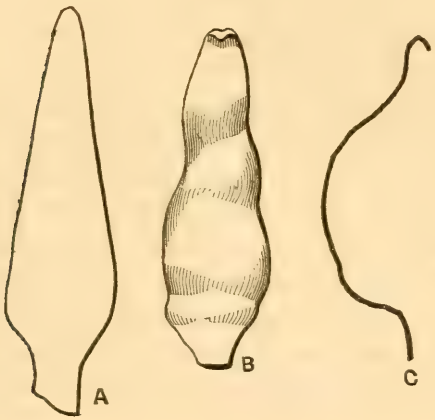
Schoolcraft mentions in his History of the North American Indian Tribes, published by the U. S. Government in 1847, that he had seen among some old bones at Saginaw, an arrow-head imbedded in a tibia, which no force that he was able to apply could extract.

The usual range for effective service in warfare is from fifty to one hundred yards.

The point of entrance is usually indicated by a narrow

slit, the margins of which are slightly discolored, resembling very much the wound made by a small ball. The

Fig. 128.



ARROW-HEAD REMOVED FROM SCAPULA BY SURGEON CLEMENTS, U.S.A.

A. Original size and form.
B. Present size and form; front view.
C. Side view.

wound of exit resembles the wound of entrance, except that it is not discolored, and it is somewhat larger.

The wounds inflicted by these missiles are punctured and usually lacerated, so that suppuration can seldom be avoided. In some instances, however, the track of the wound, when the arrow has passed entirely through the fleshy portion of a limb, heals by first intention. Surgeons Henry and Bill think they have observed this mode of union quite often. Clements informs us, however, that of nine cases under his care, not one united by first intention, though dressed in the first instance with a view of obtaining this result. The importance of this fact, he observes,

and its bearing upon the treatment of these wounds, more especially of those of the chest and abdomen, is apparent. "Considering their shape and size, the easy separation of the head from the shaft, and the force with which they are driven, I incline to regard wounds made by arrows as of a more serious nature than those inflicted by small swords and the sharp lances of civilized nations. In view of the fact that they are lacerated wounds, it is to be considered how far the treatment adapted to wounds made by small swords and lances is applicable to those made by arrows, especially those of the chest and abdomen. My own limited experience throws no light on this point, as I have had but one case of wound of the chest, and in this the arrow glanced from the rib, and did not penetrate the cavity. I have had no case of wound of the abdomen, but I am reliably assured that they are uniformly fatal when the cavity is penetrated."

Ballingall says that many of the arrow wounds received in the Ceylon insurrection of 1817 and 1818, healed by first intention, and some even where a leg was transfixed.

Profuse hæmorrhages, extensive abscesses, empyema, and tetanus, are among the most frequent complications of these accidents, when only the external or fleshy portions of the body are implicated.

Bill relates the case of a Mexican who was shot in the groin while on horseback, the wound penetrating the femoral artery; and who, unable to receive succor, bled to death in twelve hours.

The following case, derived from the same source, is instructive as indicating the proper course to be pursued in certain examples of injuries of the nerves:

"Private Martin, of the Third Infantry, was shot in his right leg by an arrow—the arrow passing out. I saw him

shortly after the receipt of the injury. The only thing remarkable was the agonizing pain, referable to the small toes and the outside of the foot. I suspected a wound of the musculo-cutaneous nerve, and decided to cut down upon it, and if necessary divide it. This I did, and found the nerve wounded. I divided it and the pain ceased, numbness taking its place. The man did well, the wound healing by granulation, and ultimately sensation was regained in the outside of his foot. This man was sent to duty on the twenty-eighth day. Of course such an operation will not be rashly undertaken upon a large nerve-trunk, nor in any case in which pain is absent." We have adopted a similar practice in certain cases of gunshot injuries of nerves attended with great pain, and with satisfactory results.

But the great source of embarrassment and of danger in these accidents has not yet been alluded to—we refer to the difficulty of removing an arrow which has lodged in any portion of the body, without leaving its head.

To understand this fully, we must again refer the reader to the description which has been given of the form of the head—expanded or barbed, and serrated—and especially to the manner in which it is made fast to the shaft. Immediately that it has lodged itself in the tissues, the tendinous thong with which it is secured begins to soften and loosen, and very soon it embraces the neck so feebly, that the slightest effort to withdraw the weapon by pulling upon the shaft, separates them completely, and the head is left buried in the body. This will happen generally, even though the head has only penetrated beneath the skin; but if it is more deeply situated, and especially if it has fastened itself into the bone, the extraction becomes exceedingly difficult. Says Surgeon Clements: "It may be considered

impossible to extract an arrow by drawing upon the shaft when the head has penetrated below the skin; and I think it should never be attempted, for the shaft being separated, the best guide to the position of the head is thus lost."

If the arrow has passed nearly through, so that its point can be felt upon the opposite side, the surgeon should cut down upon it by a counter-incision, and extract it by that route, as suggested by Larrey; and in order to facilitate its removal in this direction he may, as soon as the head of the arrow is withdrawn, and the end of the shaft to which it is attached can be seized by the forceps, cut off the opposite end of the shaft close to the skin by a pair of bone-cutters; or if he finds the head and shaft separated, he may withdraw the shaft on one side and the head on the other—taking care, however, that the tendinous string is brought out with the head, otherwise it may be left in the track of the wound.

The same practice may sometimes be adopted, namely, making a counter-incision to reach the head, even though the head is not felt, provided the surgeon can determine the length of the shaft, and consequently the probable position of the head. This is sometimes possible, since the same tribes usually employ shafts of about the same length. Thus, it is stated by Bill that the Nabahoe and Utah arrow is about two and a half feet long; while the arrow used by the Apache, Camanche, Arrapahoe, Cheyenne, Kiowa, and Pawnee, is about two feet and three-quarters in length.

If the arrow has only entered beneath the skin it will be easily removed by enlarging the external opening with a knife, and seizing upon the head with the fingers or a pair of forceps.

When it has penetrated to a greater depth, and cannot be reached from the opposite side, its extraction is some-

times rendered impossible. It must be fully understood, however, that the missile cannot remain without causing excessive suppuration, and perhaps death. It is so much the more dangerous than a ball, as it is usually larger and much more irregular upon its surface. Deep and extensive incisions are, therefore, always justifiable when the extraction of the weapon renders them necessary.

Generally the shaft of the arrow is so firmly grasped by the integuments and muscles, that it is found impossible to introduce even a small instrument into the wound. It must, therefore, be enlarged through its whole length, and then the finger must be carefully conducted along the shaft until the head is reached, when a long pair of bullet-forceps may be carried down and the extraction of the head safely effected.

Bill, in a case of this kind, where the arrow had penetrated the chest, introduced a wire having a loop at one end, which loop was bent at a right angle with the shaft of the wire, and thus caught and extracted the head.

When the head is completely detached, the shaft having been incautiously withdrawn, the finger or a long probe may possibly disclose the track and enable the surgeon to find the head. In other cases nothing but free exploratory incisions will accomplish the purpose.

One of the most serious complications of these accidents consists in the lodgment of the point of the arrow in the bone. Bill has seen an arrow shot at a distance of one hundred yards, so deeply imbedded in an oak plank, that it required great force, applied by strong tooth-forceps, to remove it. In the case of a man shot in the shaft of the humerus by an arrow, it was only after using both knees, applied to the ends of the bone as a counter-extending force, that he succeeded in removing the foreign body.

Assistant Surgeon McKee had a case, also, in which considerable force was required to extract an arrow-head lodged in the trochanter.

The fact that the arrow has penetrated the bone may generally be ascertained by seizing the shaft between the fingers and giving to it a gentle rotatory motion.

The mode of procedure in this case is as follows: Having determined by a free enlargement of the whole track of the wound, and by a careful exploration made with the finger, the precise point where the head is lodged, and its depth of penetration in the bone, we next attempt to ascertain in what direction the long transverse axis of the head lies, in order that we may loosen it somewhat by a gentle rocking motion, before we attempt its extraction. This may be ascertained, when the head is not too deeply situated, by the finger. If it cannot be reached by the finger, then the instructions given are to notice in what direction the groove is made on the outer or feather-end of the shaft, designed to receive the bow-string, and rock the shaft to and fro gently in a direction at a right angle with the plane of this groove. The reasons given for making the motion in this direction are not very satisfactory, but we are assured that the Mexicans frequently practise this method successfully. The recommendation seems to be based upon the supposition that the plane of the long transverse diameter of the arrow-head is always, or generally, at a right angle with the plane of the groove in the feather-end of the arrow; but this is not the fact—the planes of the two being in most cases the same.

It must not be forgotten, however, that by moving the shaft too freely or too persistently, we endanger a separation of the head from the shaft, or a fracture of the head at the point where it enters the bone. In a large pro-

portion of cases this method fails, but it always merits a trial.

As soon as it is felt to be somewhat loosened, the forceps must be introduced, and the head seized and extracted with the shaft.

The arrow-head being firmly lodged in the bone after the shaft has been withdrawn, renders it necessary in most cases to make exploratory incisions; but it is less difficult to discover the position of the head when it is thus lodged than when it lies loose in the soft tissues. It does not change its position, and it can be more readily felt.

The following is an example of this kind, related by Bill:

"Private Bishop was shot in the head of the humerus with an arrow, and the shaft having been plucked out, the iron head was left deeply imbedded in the bone. The man was in great pain, synovia was flowing out of the wound, and all motion was lost. I enlarged the wound, introduced my finger, and so ascertained the position and depth of the arrow-head. It was very deeply implanted. I introduced forceps, seized it by its base, but could obtain scarcely any purchase. I at last succeeded in grasping it tightly, and bracing my knees against the patient's thorax, I applied all the traction I could master. Suddenly the arrow-head flew out of its seat, and I would have fallen on the floor, had not the steward caught me. The wound healed well. It was treated by evaporating lotions and a rigorous diet. Motion in the joint was not lost, though somewhat impaired."

There is one other condition of the iron arrow-head which has several times been noticed by army surgeons who have had experience in Indian warfare. An arrow impinging upon the side of a bone, passes onward between the bone

on the one hand, and the periosteum, with its immediate fibrous and muscular envelopes on the other hand, the point bending as it progresses; so that finally it is made to embrace a portion of the circumference of the bone like a hook, and in this condition its extraction becomes exceedingly difficult. Bill has met with two cases of this kind.

The first was that of a Mexican shot by an Apache. The arrow entered on the ulnar side of the forearm, about one inch below the coronoid process, its point passing around behind the ulna, closely embracing the bone, until it reached quite to the radial side. In this situation it was readily discovered by the finger, and by the exercise of much care it was removed.

The second case was that of Corporal Scott, shot at Fort Defiance by a Nabahoe. The arrow entered on the posterior and outer aspect of the leg, "penetrated the muscles of the calf, scraped the fibula about two inches from its head, and then wrapped itself firmly around this bone." The hæmorrhage being profuse and arterial, Bill immediately enlarged the wound, followed the arrow to its head with his finger, and then extracted it. Some difficulty occurred in controlling the hæmorrhage, but this was finally overcome, and the man made a complete but tedious recovery.

Dr. Kennon removed an arrow-head which had been lodged in the femur of a Mexican six months, causing caries and extensive purulent infiltration into the tissues. It was reached after a prolonged and bloody dissection, and it was then ascertained "that the soft iron of which the head was made had bent into a semicircle, and that the femur was half surrounded by the extremity of the weapon."

When it can be ascertained that the condition and position of the arrow are such as has now been described, it

must be seized very firmly, and pressed in various directions until it is somewhat loosened, and then brought out as much in the line of the curve of the bone as the external wound will permit. By employing considerable force, also, in a direct line, the arrow-head will tend to straighten itself, and the extraction may be accomplished. This cannot be practised with safety, however, unless the forceps actually grasp and hold firmly the head.

The following is a summary of eighty cases of arrow wounds recorded by Bill:

Upper extremities, 28: of these 1 died.
Lower extremities, 6: of these 1 died.
Head, superficial, 2: both recovered.
Head, penetrating the skull, 3: 2 died.
Spinal marrow, 1: died.
Chest, superficial, 9: all recovered.
Chest, penetrating the lungs, 6: 4 died.
Chest, penetrating the heart, 2: both died.
Abdomen, intestines not wounded, 6: 3 died, but of these one perished from a gunshot wound.
Abdomen, intestines wounded, 15: all died.

It will be observed that the largest number of wounds are in the upper extremities. This circumstance the writer ascribes to the fact that a person can see an arrow approaching, and instinctively raises his arm to ward it off from his more vital parts. We think it quite as probable that the explanation may be found in a well understood peculiarity of Indian warfare, where both parties conceal their bodies as much as possible behind trees, while their arms are necessarily exposed in the act of discharging their weapons.

The wounds of the abdomen are next in point of frequency. Savages know very well the fatality of these

wounds, and consequently direct their missiles towards the belly whenever the opportunity is offered.

Bill remarks that "an expert bowman can easily discharge six arrows per minute, and a man wounded with one is almost sure to receive several arrows. In the above table" (of which we have made a summary) "when a man was wounded in more than one place, the most serious wound, or that which immediately caused his death, is recorded. We have not seen more than one or two men wounded by a single arrow only. In three of our soldiers shot by Navajoes, we counted forty-two arrow wounds; this is an extreme case, as the manufacture of the arrow costs the Indian too much labor and time to expend one unnecessarily."

As to the fatality of these wounds, it will be noticed that arrow wounds of the extremities are less liable to cause death than the average of gunshot wounds at the present day. This is especially true as regards the lower extremities. In this respect, indeed, they resemble rather the wounds made by round, smooth balls and pistol shots. The reason for this difference is apparent. They occasion very little or no shock, unless they have penetrated vital organs; the wounds are comparatively smaller than those made by rifle balls; and the bones are not often broken and comminuted by arrows. It is only when the head of the arrow remains behind, causing caries and suppuration, or when important arteries or nerves are injured, that arrow wounds of the extremities can be considered dangerous.

Penetrating and perforating arrow wounds of the abdomen, chest, and head, however, seem to be nearly or quite as fatal as gunshot wounds of the same regions.

Ballingall gives an abstract of the returns of cases of

gunshot and arrow wounds, made by six of the medical officers employed in the Kandyan provinces in Ceylon, during the insurrection of 1817 and 1818, from which it appears that of twenty-two gunshot injuries of the extremities, none died (it will be remembered that the conical ball was not then in use); and of twenty-five arrow wounds of the extremities, none died. Of eighteen gunshot wounds of the head, neck, and trunk, only two died; and of sixteen arrow wounds of the same portions of the body, only one died. No distinction is here made between superficial and penetrating wounds, and for this reason these latter figures possess very little value.

Taken together, however, the reports of the Ceylon surgeons show that there is not much difference between the mortality of wounds inflicted by round, smooth musket balls and those inflicted by arrows.

As to the immediate causes of death, Bill ascertained that in a total of twenty-seven cases, thirteen died of peritonitis; nine of immediate hæmorrhage, including two who received the wounds in the heart; two of compression of the brain; one of pyothorax; one of tetanus; and one of pneumonia, probably the result of pyæmia.

Section II.—Arrow Wounds of the Head.—An arrow which strikes the cranium obliquely seldom penetrates, and causes only a scalp wound. These accidents demand no special consideration.

An arrow which strikes the cranium perpendicularly to its surface and at a short range, usually penetrates the bone, but not to a great depth. The outer plate is simply perforated, and not properly speaking broken, except that a fissure is frequently found extending laterally through the bone from the two opposite angles of the puncture.

The inner plate being more friable, is usually broken, a small scale or fragment, into which the point of the arrow becomes fastened, being pushed inwards upon the brain, and causing to a greater or less extent symptoms of compression. These fragments are seldom driven fairly through the membranes and into the structure of the brain.

Bill observes that the surgeon is rarely called upon to treat these cases, since the moment a man is rendered insensible and falls, the savages, if within reach of him, rush upon him and complete the work of destruction.

If, however, the wounded man fall into the hands of the surgeon, he will sometimes have occasion to notice that when the arrow is drawn outwards the compression is relieved, because the point being fast in the inner fragment, the latter is drawn outwards at the same moment.

In these cases, in the opinion of Bill, the operation of trephining is unnecessary, and he refers to the following cases in illustration of the correctness of this opinion:

"Miguel Nigro, the post-guide at Fort Union, was shot with an arrow by a Utah Indian. I found the arrow-head sticking in the left parietal bone, the shaft having been detached. I made traction on it and drew it out of the wound. The symptoms of compression present at once vanished, the man turned over and sneezed, and rose upon his feet. I had made arrangements to trephine the skull, if necessary, but I had probably restored to its proper level that portion of the inner table which was depressed, so that measure was unnecessary. The cause of the depression was gone, and I had nothing to trephine for. The next day the man complained of headache; his face was flushed, eyes suffused, pulse hard and irregular. I ordered croton oil, shaved his head, and applied cold. Presently, when delirium came on, I bled him until he fainted. This bleed-

ing was repeated the night of the same day. The next day he was greatly better; the croton oil had operated well. The man was left to recover, which he did in three weeks.

"We have examined two other cases of arrow wounds of the skull. In both the subjects were dead. In both there was a depression of the inner, with a fissure of the outer table. In one of the cases the wound was over the right frontal bone, and this was fissured into the coronal suture. The depressed portion of the inner table measured half an inch in diameter, and was firmly attached to the point of the arrow-head, so that on withdrawing this latter, I could readily elevate the depressed scale. The second case was that of an Indian, shot with an arrow in one of the Wormian bones. The inner table was just barely pierced by the arrow-point. The fragment of the bone depressed was driven upon the membranes over the left posterior central lobe, without, however, tearing these. In neither case was hæmorrhage observed; neither died immediately.

"Lieutenant Maxwell was shot in the head by an arrow which penetrated his skull, wounding the brain, and killed him almost instantly. We did not see the case, and therefore refrain from noticing it farther."

These observations are of very great value, yet they leave undetermined some interesting points of inquiry. The cases referred to do not instruct us in what proportion of similar injuries the small, loose fragment, thus restored to position by withdrawing the arrow, will become again consolidated and a complete recovery follow; and in what proportion death will finally ensue from necrosis of the fragment, and consequent suppuration and compression. They do not finally determine whether, after all, in the cases stated, it might not be safer to employ the trephine.

It is certain that if, on withdrawing the arrow, the signs of compression do not disappear, the trephine ought to be promptly applied. We must take care, however, to distinguish between the signs of compression and those of mere concussion. It is not our intention to note the points of distinction very minutely. They are familiar to all students of surgery. In general it may be said that the signs of concussion are those of partial paralysis, consenting or alternating with a certain amount of morbid irritability; while the signs of compression are those of more complete paralysis, unaccompanied with any degree of irritability. Concussion is usually brief and temporary; compression is relatively permanent.

Arrows received upon the bones of the face may penetrate to a very great depth, and their extraction become exceedingly difficult. Like gunshot injuries of the face, also, they are very apt to be complicated with troublesome hæmorrhages.

For the following examples we are indebted to Dr. C. A. Pope, Professor of Surgery in the St. Louis Medical College, Mo.:

"The late General Bayard, who was killed at the battle of Fredericksburg, in a skirmish with the Indians in New Mexico, on the 11th of July, 1860, when a Lieutenant in the U. S. Army, received an arrow-shot in the left superior maxilla. The spear-shaped iron point, two and three-quarter inches long, with a small neck for the fastening of the wooden portion of the arrow by means of the sinews of the deer, entered the face a little below the orbit and was completely imbedded up to the shoulder, the small neck alone remaining in the flesh. Its direction was backwards and slightly outwards. The Surgeon of the Post immediately endeavored to extract the foreign body. At

first it was hoped that this might be accomplished by forcible traction upon the arrow itself. The only effect of this, however, was to detach the feathered wooden shaft from the iron-headed point, which remained firmly impacted in the bone. Various means with forceps were then resorted to, and after a trial of two hours the effort at extraction was abandoned. The absence of a suitable instrument, the slight hold which could be obtained on the offending body, and above all the firm impaction, sufficiently account for the failure. The difficulties in such cases are always great, as attested by the variously contrived appliances for the purpose, from those of Ambrose Paré to the more recent ones of Velpeau.

"Slight secondary hæmorrhage from the nose followed within the subsequent few weeks, when he left New Mexico to return home. On arriving at St. Joseph, a more serious bleeding occurred.

"The patient reached St. Louis five weeks after the receipt of the injury. I visited him immediately. There was some enlargement of the left side of the face. The wound on the cheek had skinned over, so that no foreign substance could be seen, nor would have been suspected. On gently pressing with the finger, a hard point was felt beneath the integuments. A muco-purulent discharge issued from the corresponding nostril, which came, doubtless, from the antrum.

"On incising the imperfect cicatrix, I felt the small neck, and supposing that the arrow-head after so long a time might be somewhat loosened, I attempted its extraction with the dressing-forceps of my pocket-case, but failed. I at once supplied myself with instruments of various kinds, but succeeded in a first attempt with a pair of powerful forceps. A smart hæmorrhage from the nostril and exter-

nal wound immediately followed. By rest, opium, cold, plugging, and bandage, the bleeding was soon arrested. Several slight hæmorrhages subsequently occurred, but gave rise to no uneasiness.

"The case now seemed to progress favorably, and he was soon able to get about the streets. On a visit to my office he complained of a stiffness and inability to separate the jaws as widely as usual—a difficulty, indeed, which had existed all along, and was the result of the general thickening of the parts from inflammatory exudation. I advised him to make gentle efforts to open the mouth. In less than an hour from this time his troubles commenced. The whole cheek became hot, swollen, and painful. High fever, with renewed hæmorrhage, set in, and caused me much anxiety. The means which were before successful now failed. Extensive extravasations of blood took place, and to relieve the tension, I made free incisions both in the mouth and on the cheek and neck, from which large grumous clots were pressed out.

"The hæmorrhage continuing at intervals, and finally on three successive nights occurring with regularity at about twelve o'clock, and the patient being reduced to the lowest point of safety, I determined to tie the carotid without delay.

"This was done by candlelight on the night of the 16th of September, two months after the receipt of the injury. Such was the extreme condition of the patient, that he fainted during the operation, although he was in the recumbent position. The operation itself was a delicate and difficult one, as the parts were very much swollen and altered in their relations by infiltration.

"The bleeding never recurred, and the final recovery of the patient was complete."

SECTION III.—ARROW WOUNDS OF THE CHEST.—Arrow wounds of the chest are in general superficial—that is to say, the lungs are not generally penetrated. Of fifteen cases of thoracic arrow wounds seen by Bill, only seven involved the lungs. The size of the arrow at its broadest portion is generally such, that, unless it enters with its longest diameter more or less parallel to the axis of the ribs, it will be arrested; and although the thoracic cavity may be penetrated, the lungs are not necessarily wounded.

The treatment of these superficial wounds caused by arrows should be conducted upon the same principles as the treatment of superficial punctured, incised, or lacerated wounds of the chest occasioned by swords or bayonets.

Arrows sometimes transfix the thorax completely. This is the exception to the rule, since in most cases they penetrate and become lodged. In either case the patient is in more danger from hæmorrhage than after ball wounds, for the reason that the vessels are more incised than contused or lacerated. Considering, therefore, the greater chance of their becoming lodged, with the great size and irregularity of the arrow-head, and the increased danger of hæmorrhage, arrow wounds penetrating the lungs must on the whole be regarded as more dangerous than bullet wounds. Of six cases of arrow wounds of the lungs seen by Bill, in Mexico, four died; two by hæmorrhage, one by pneumonia, and one by pyothorax. This does not include one other case in which the heart was also penetrated and the patient died.

The following are the cases reported as having died of hæmorrhage:

In an attack made by a company of Mexicans on the Nabahoe Indians, a man was found dead among the others with three arrow wounds, two of which were of the lungs.

One arrow had entered below the right nipple and lodged in the body of a vertebra; the other had passed entirely through the chest from right to left. No large bloodvessels were wounded, but about one quart of blood was found in the left pleural cavity, and a somewhat smaller quantity in the right.

Private Connor, 3d Infantry, received four arrows, all of which passed through the lungs. He died in a few minutes, apparently asphyxiated with the torrents of blood poured into the bronchi. The vena cava descendens was found pinned to one of the vertebræ by an arrow-head, and the aorta pierced by a small arrow-head. Both wounds were completely plugged by the arrow-shafts.

When an arrow has entered the thorax and has lodged, the surgeon will first seek to ascertain the depth and precise position of the head. Its depth may possibly be determined, as we have before mentioned, by comparing the length of the projecting portion of the shaft with the length of other arrows used by the same tribe. The finger or a probe may be conducted carefully along the side of the shaft, after having sufficiently enlarged the external wound, until, perhaps, the head may be felt. A thorough examination should be instituted upon the opposite side of the chest, to ascertain whether the point may not have approached the skin in that direction. Especially, however, will the surgeon seek to ascertain whether the arrow is lodged in a rib or the spine; and for this purpose he will first take the shaft between his thumb and finger, and attempt to rotate it gently; if impacted in bone it will be almost immovable; if not, the slight resistance felt will probably indicate the fact. In order to ascertain precisely what portion of the bony parietes of the chest has been penetrated, he will observe the line of the axis of the shaft,

and then, placing his fingers upon the suspected point, he will gently percuss the outer end of the shaft, moving his fingers from place to place until the point of most distinct vibration is determined.

The surgeon ought also to give attention to the amount and character of the hæmorrhage, ascertained by moving the shaft a little to one side in order to allow the blood to escape. If it escapes very freely, and is of a bright arterial color, the prognosis is fatal, and interference can only hasten the death of the sufferer.

In case the arrow-head lies just beneath the ribs, after having freely enlarged the external wound, it may perhaps be seized with forceps and extracted.

If it is situated much more deeply, the forceps will not reach it, and then the surgeon ought to avail himself of the ingenious contrivance successfully employed by Bill, and which we have already described, namely, a wire constructed with a loop so as to catch the point of the arrow-head. The case in which this ingenious surgeon employed the wire-hook is as follows: A man had received an arrow between the fourth and fifth ribs on the right side. The shaft was broken off close to the wound, and the splintered end of the shaft closely resembled the point of a broken rib. As soon as reaction was established, Dr. Bill proceeded to determine the depth and precise position of the head in the manner we have prescribed, and the conclusion to which he arrived was, that the lung was penetrated to the depth of five inches, and that the line of the shaft was directed towards the inferior angle of the scapula; the point was not lodged in bone; there was no hæmorrhage. Enlarging the external wound to the extent of an inch with a probe-pointed bistoury, he introduced the wire, using the shaft as a guide, "until its loop was past the point of the arrow-

head; and slipping the loop over the point of this, and then drawing the wire gently back, it was found from the sense of resistance that the loop had snared the treacherous body." Only gentle traction was required to remove it. The wound was closed with collodion dressing, and the patient directed to lie on the wounded side. Moderate inflammation supervened, but the patient speedily recovered without any further medical or surgical interference.

If the arrow is found to have lodged in a bone, and the shaft remains attached, then first of all we may endeavor to loosen it by a gentle rocking motion, as already described in our general observations. If this fails, the patient must not be abandoned in the hope that it will finally become loosened. If it does become loosened eventually by suppuration, the shaft will also certainly be found separated; but the truth is, that it is not apt to loosen speedily, and death by pneumonia or pyothorax will inevitably occur.

Bill has never had a case of this kind to treat, but he has made numerous experiments on the cadaver with various instruments and contrivances to extract the arrow-head, and concludes that the following plan will be found the most safe and practicable. We understand the writer, however, to say that this method is especially applicable to arrows passing through the chest, and lodged in the vertebræ. For the removal of arrows lodged in a rib he recommends another method:

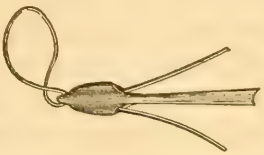
"Procure a piece of very well annealed iron wire, a little larger than the coarsest usually employed for sutures. Let this be about two feet and a half in length. Pass the ends of this wire through the holes in a very long Coghill's suture wire-twister (Fig. 124) and carry them up the shaft of this, securing their ends to the handle. The loop at the end of

Fig. 124.

COGHILL'S SUTURE WIRE-TWISTER.

the instrument, made by the doubling of the wire, should now be once twisted upon itself, and then bent at right angles to the shaft of the instrument. (Fig. 125.) This

Fig. 125.



SECTION OF COGHILL'S SUTURE WIRE-TWISTER, WITH THE WIRE INTRODUCED AND READY FOR USE.

shaft should be at least one foot in length. Then the wound being sufficiently enlarged, pass the loop at the end of the twister over the feather end of the arrow-shaft, and using this last as a guide, push the instrument straight on till the loop of wire is carried beyond the arrow-shaft and is encircling the arrow-head. Now draw on one of the ends of the wire, so as to make the loop embrace the arrow-head tightly, and secure the end of the wire to the handle of the instrument; one or two twists of this will suffice to tighten the wire so that it cannot slip off from the arrow-head, and all that is now necessary is to make firm but gentle traction on the handles of the twister, gently rocking the arrow-shaft to and fro at the same time, in order to disengage the head of the arrow from the bone."

If the head is very firmly fixed, it is suggested that an

additional instrument armed with wire shall be made to grasp the head, and that the two twisters being bound together, shall be drawn upon by the steady action of a lever made fast to their outer ends.

A long double canula, or two silver catheters soldered together, might be substituted in an emergency for Coghill's suture twister.

In the following case the head was lodged in the spine, but the shaft being removed, it could not be extracted, and the patient died:

"Santiago Orliz was shot in the left armpit by an arrow. The shaft of the arrow had been pulled out two days before I saw him, leaving the head lodged firmly in the fourth dorsal vertebra. The hæmorrhage, I was informed, had been very great. This his Mexican comrades restrained by plugging the wound. I made an examination with a probe, but failed to detect the foreign body. I gave up the search, enlarged the wound, introduced a common tent, and contented myself with an expectant plan. In three days the wound discharged matter in large quantity. I again searched for the arrow-head, but without success. The wound was made in the depending part of the body, and I hoped that the foreign substance might make its way out, and, moreover, that empyema might be thus prevented. But all in vain; the man died asphyxiated from inability to throw off by his mouth the matter which was constantly being coughed up. Inspection two hours after death showed a wound between the fourth and fifth ribs. The track of the arrow had healed for an inch or more, and thence was open to the fourth dorsal vertebra, which was found to have been wounded, the wound being filled up with a cartilaginous cicatrix. The pleural cavity was distended with matter, but did not communicate with the

external wound; the pleura-costalis and the pleura-pulmonalis being united at this point. The pleural cavity communicated with the fistulous track in the lung tissue. I was deceived in this case. I supposed that the external wound would allow of the drainage of all the matter that could form; whereas, in fact, it did not allow of any discharge at all from the pleural cavity. I should have been more attentive to the physical signs, and at least have made an exploratory puncture to determine the presence or absence of matter in the pleural cavity, and then I would have performed paracentesis. I found the arrow-head resting on the diaphragm, it having ulcerated through the pleura; and I have no doubt that in time it would have perforated the diaphragm and slipped into the abdominal cavity. It was very crooked; the long thoracic artery had been divided by the arrow-head, but no vessel of importance was injured."

When the arrow is lodged in a rib within the walls of the chest, and its exact position can be ascertained, Bill recommends that the trephine be applied, and that portion of the rib which sustains the arrow be removed; taking care not to injure the intercostal artery, which is lodged, through a greater part of its course, just within the lower margin of the rib. "It is very easy to make the opening in the rib within the eighth of an inch of the arrow-head; and sometimes we can hit the spot exactly, and on attempting to withdraw the circle of bone we find the arrow firmly imbedded in it."

SECTION IV.—ARROW WOUNDS OF THE ABDOMEN.—Bill has seen twenty-one cases of arrow wounds of the abdomen; of these, in three cases only the integuments were wounded, and in one the arrow-head lodged in the

crest of the ilium without wounding an intestine; in only one case, where the abdominal cavity was opened, did the patient recover.

Of seventeen fatal cases, thirteen died from peritonitis, and four from hæmorrhage. Nine of the cases of peritonitis had been exposed to a broiling sun, without water, for two days. Five died soon, and none lived to reach the Post. In all, fæcal matter was found in the peritoneal cavity.

As distinguished from gunshot wounds of the abdomen, arrow wounds possess these peculiarities: the arrow-head is lodged more often than the ball, and if it is not removed the patient will more certainly die. If the shaft remains attached to the head, it is also more easy to find and to remove the head than it is to find and remove a ball. No reasonable effort ought, therefore, to be omitted to accomplish the extraction, whether the arrow is merely lodged among the viscera or in a bone. For this purpose the wound must be enlarged, and some of those various methods of procedure adopted which have already been described when speaking of arrow wounds in general, and of arrow wounds of the chest.

As to the subsequent treatment of the wound, and of the patient generally, we refer the reader to our remarks upon gunshot and punctured wounds of the abdomen, for the rules and principles which ought to govern his practice in this case.

The following is an account of one of the fatal cases of belly wounds. It was complicated with a wound of the stomach, liver, and of both lungs:

"Salvador Martinez was shot through the chest with an arrow, which entered between the fifth and sixth ribs on the right side, and passed out between the seventh and

eighth on the left. He vomited blood. The arrow had been extracted when I saw him. I had him taken to Fort Defiance, where he arrived very much exhausted." At bed-time he took half a grain of sulphate of morphia, and in the morning an enema, followed by an injection of essence of beef and wine. No nourishment was given by his mouth. The following evening his respiration became difficult, and the wound, which had been closed by soft leather soaked in collodion, was opened, causing the discharge of a large quantity of blood, serum, and pus. The wound was enlarged, and a sponge-tent introduced. The breathing was relieved. The treatment from this time remained essentially the same, consisting of the administration of morphia by the mouth, and of beef-essence, laudanum, quinine, and wine-whey by the rectum. Pneumonia and peritonitis supervened, and blood was abstracted locally. The quinine was especially given in large doses, to control the pneumonia and peritonitis. The peritonitis was subdued on the tenth day, and the patient died on the sixteenth.

Upon examination after death, the right lung was found solidified and engorged with pus. Left lung contained a cavity of the size of a pigeon's egg, and much pus was found through its structure. The arrow-head penetrated the right lung, the diaphragm, the liver, the stomach at its posterior and cardiac aspect, and finally the left lung. The wound in the stomach had healed. The wound in the liver was open, and communicated with the wound in the right lung.

The case of recovery after a wound of the peritoneum is as follows:

"A Mexican, while travelling the road near Fort Defiance, was shot by the Nabahoes with five arrows, all the

arrows injuring the lung, and one passing through the upper border of the liver. I saw the man twenty minutes after the accident. The bleeding was most profuse, and the man fainted. Both lungs were wounded; I made the worst possible prognosis, but proceeded to extract the arrows, all of which I safely removed. After the hæmorrhage had ceased, I applied muslin soaked in collodion to each of the wounds, eight in number, and had the patient put to bed, and given a grain of morphia. The next morning the patient was more comfortable than I had expected. He had been vomiting, and I gave him some acetum opii and acetate of lead to quiet this and restrain secretion. In the afternoon the man complained of pain on the right side and difficulty in breathing. I removed the dressing from the wound involving the liver and lung, and broke up some clots, whereupon a considerable quantity of mixed fluids was discharged from the wound. These contained bile, as I discovered by Pettenkofer's test. This procedure greatly relieved him, and he expressed himself much better. I ordered the prescriptions of the morning to be repeated. The next day the patient vomited a considerable quantity of black decomposed blood, and complained of the frequency of his urination. Urine very dark-colored, sp. gr. 1036, containing cholic acid and sugar. All medicines ordered to be discontinued. After this the patient gradually recovered, all the wounds healing by first intention, except that implicating the liver, and that ceased discharging on the sixth day. In two weeks the man left the hospital, his urine still containing sugar, but no bile. He had passed during his illness about thirty-six ounces per diem. In a few days the last traces of sugar disappeared from his urine, and in six weeks from the day he was wounded, he returned to the Post from a scout, in order to

have removed a large polypus of the nasal cavity, which had plagued him a great deal during his absence."

The writer adds: "This case is remarkable, showing as it does what injuries a man may sometimes survive. It also proves that wounds of the lungs sometimes heal by first intention (we have noticed in New Mexico a great tendency of all wounds to heal by this process), and it illustrates a common occurrence after liver wounds—the presence of bile and sugar in the urine. It shows, moreover, that the hepatic peritoneum may be wounded by an arrow without death resulting, or the effusion of blood or bile into the cavity of the abdomen. Finally, it is a good example of the treatment proper in such cases. In this instance, as well as in two of the fatal cases of arrow wound of lung. emphysema was present. It was not particularly treated, save that, when possible, Guthrie's rule was observed, the patient lying on the wounded side."

We shall make no apology for the freedom with which we have constantly employed the pages of Assistant Surgeon Bill's excellent paper on the subject of Arrow Wounds. No one else has written so fully, and the reader must be struck with the judgment and ingenuity which characterize his practice, with the brevity yet completeness of his reports of cases, and with the soundness of his suggestions. In conclusion, after stating that the Mexicans, on entering into an Indian fight, wrap many folds of a blanket around the abdomen, the wounds of which portion of the body are above all others the most fatal, this experienced surgeon adds:

"We wish to recommend to those in authority the plan of protecting soldiers and others exposed to arrow wounds, with a light cuirass. The Indians have a method of dressing bull's hide for shields for themselves, which renders it

arrow-proof. A cuirass made of such material, protecting the whole trunk before and behind, need not weigh more than eight or ten pounds, and by means of it a soldier could enter an Indian fight with a fair chance of escaping death. Or perhaps the recently invented bullet-proof vests might be found better adapted to the service, and equally effective. Certainly it is policy in fighting any enemy to make it as safe for ourselves as possible, and as dangerous for him. Sooner or later the Government must undertake some great expedition against all the Indians of the plains. It may be possible to civilize Creeks, Choctaws, Cherokees, etc.; but with a Cheyenne, or Camanche, or Apache, the attempt will surely fail. The hands of these Indians ever have been and ever will be against every man. They are the professed exponents and great advocates of barbarism and universal ignorance. In view of any such plan of a general civilization of these tribes, we think it should be the care of those who control such things to provide, as far as possible, for the safety of the soldier. We are certain that if suitable bull's-hide cuirasses were provided, fatal wounds from arrows would become very rare.

"In all commands engaged against Indians, an order should be issued warning the men of the danger of attempting to extract an arrow, and directing them in all such cases to go at once to the surgeon in attendance for assistance. From what has been already written, it is easy to see how great an advantage such a course will give a surgeon in the treatment of the injury."

Section V.—Poisoned Arrow Wounds.—No doubt many savage tribes have practised poisoning their arrows in order to render the wounds inflicted by them more certainly fatal. It is stated upon very good authority that the

natives of the Island of Java poison their weapons by dipping their points in the juice of the upas tree; and the natives of South America employ for the same purpose the woorara or wooraly.

But it is probable that the extent to which this practice has been carried is very greatly exaggerated by travellers. For example, Good, in his "Study of Medicine," mentions an observation of Garcilaso de la Vega, in his History of the Spaniards in the Indies, to the effect that "all the Indians in the westward islands poison their arrows by dipping their points in dead bodies." It is possible that this may have been done occasionally by the Indian; but it is not likely that the practice was at all general or universal, since experience would soon prove that the weapons thus treated had acquired no poisonous properties.

Among the North American Indians, this practice is almost unknown. Surgeon Edgar of the U.S.Army, thinks that it is confined to the tribes inhabiting the mountainous regions watered by the Pitt River, one of the northern branches of the Sacramento. "These people, it is said, use the poison of the rattlesnake, by grinding the dried head of that reptile into an impalpable powder, which is then applied by means of putrid blood and flesh of the dog to the point of the weapon."

Bill says: "It is occasionally the practice of our Indian tribes to poison their arrows. The plan pursued is this (on the testimony of a Moquis Indian): The liver of some animal is exposed, and a rattlesnake compelled to insert his fang into it. The animal is at once killed, the liver removed and wrapped up in the skin and buried. After seven or eight days the bundle is dug up, and the arrowheads dipped in the pulpy and putrescent mass inclosed in the skin. After they are dry they are dipped in blood, again

dried and preserved for use." The writer adds: "We have never witnessed this process, but have seen arrows said to have been subjected to it. A horse, however, was shot on a late Nabahoe expedition in the flank with an arrow. He swelled up enormously, evidently suffered much pain, and died in the course of the night, certainly from the effects of a poison, as the wound inflicted by the arrow was not mortal, either from its seat or severity. Strange to say, such arrows are of infrequent use. Among some seventy-six cases of arrow wounds received from Nabahoe, Apache, and Utah Indians, we have seen no case of poisoned arrow wound in the human subject, nor have we heard of such a case after careful inquiry. Of course a wound of this nature, if it involves parts beyond the reach of the knife or cautery, is fatal."

CHAPTER XXI.

TRAUMATIC GANGRENE.

As a sequence of gunshot injuries, Traumatic Gangrene may occur during the primary period, before reaction is fairly established; during the intermediary period, while the acute inflammation, or acute œdema, is in progress; or during the secondary period, or the period of suppuration.

The gangrene of the first period, or that which anticipates reaction, is due in some cases to the severity of the original injury; the contusion or laceration being such that the vitality of the tissues is from the first completely destroyed, or so much lowered that it is impossible for their functions to be restored. This species of gangrene can in many instances be prognosticated with certainty from the appearance presented by the parts which are injured. More or less of the circumference of nearly all gunshot wounds dies in a few hours, if not immediately, and will separate in a few days by the natural process of disintegration to which all dead animal matter, exposed to the action of the air and moisture, is subject. But this process of separation is greatly expedited and completed at last, by the occurrence of suppuration. Gangrene thus produced does not extend beyond the parts originally injured; it is self-limited and rarely gives the surgeon much anxiety.

The treatment is precisely that which has already been indicated as suitable for the majority of gunshot wounds in the first instance, namely, tepid water applications. It is

only when the sloughs are unusually large, or when the disintegration is very rapid, giving rise to offensive odors, that antiseptic poultices, such as yeast, charcoal, etc., become necessary.

Gangrene may be occasioned during this period, also, by the tightness of a bandage, or by pressure of any kind. In such a case the prognosis and treatment may be easily determined. If the death is occurring only at the point where the pressure was made, it will probably not extend farther; but if it is presented in the course of the limb below this point, it may threaten the destruction of the entire limb, and demand sooner or later the interposition of the knife.

Extensive extravasations of blood or of serum within the sheaths of muscles, under aponeurotic fasciæ, or immediately subjacent to the skin, obstructing by their pressure venous, arterial, or even nervous circulation, cause the death of the parts in a manner similar to pressure from without; and there are many examples in which free and deep incisions at this period are demanded to arrest a gangrene already commenced and due to these causes.

Finally, a primary gangrene may occur in part from the local injury and in part from the great depression of the vital forces of the whole system; as, for example, while the patient is still laboring under the shock. In such cases the gangrene may be regarded generally as a fatal indication. If the patient is saved at all, it is not by local applications, but by the liberal use of internal stimulants and of nourishing food.

In the second, or intermediary period, the death of the part is due in most cases indirectly to the violence of the inflammatory reaction. We say indirectly, because it is probable that inflammation causes death only by increasing

the effusions, the tumefaction, and the tension of the parts. It is death by strangulation; and does not differ essentially from death occurring in the primary period as a result of effusions, except in this, that the congestions and strangulations are now mainly caused by the inflammation.

Unless we adopt this rational view of the subject, we shall not understand the value and importance of free incisions as a means of relief, and especially as a means of prevention. When death from inflammation is about to occur, the pain rapidly subsides, indicating the abolition of the sense of feeling in the part. Possibly incisions made a few hours earlier might have prevented this result, but now they will scarcely restore to vitality those structures whose sensation is lost. It is not improbable, however, that they will prevent the extension of death to some of those structures not yet completely strangulated. There are multitudes of examples in which gangrene, progressing with inflammation, is arrested by deep and long scarifications; and the only barrier to the more universal use of the knife under these circumstances, is the danger of wounding important bloodvessels; and we might add, that almost the only limit to its value is found in the fact that the effusions of fibrine possess that degree of solidity, and have so far imprisoned the other effusions by sealing up the tissues, that it is impossible to make the incisions sufficiently free to render the unbridling complete.

It frequently happens in these unfortunate cases that the progress of the death ceases spontaneously when all those tissues which were suffering the most acute congestion have sloughed; and when we are afraid to use the knife we await anxiously the result of this natural process of *débridement*. Moreover, when sphacelation occurs, the vigor of the inflammation usually subsides, even in those parts con-

siderably remote from the point of sphacelation. We do not pretend to explain this fact. Perhaps it is due to a nervous exhaustion or depletion consequent upon the destruction of those nervous filaments which are involved in the slough, and which exhaustion may extend its influences even to the great nervous centres; the effect resembling what is termed the "shock" of injuries. Other explanations may be offered, but we only desire to notice the fact that the inflammation abates, and in itself is not hereafter a controlling indication of treatment.

It may be also that the inflammation which lingers in the adjacent living tissues is changed, and that it has assumed a new character from the absorption of disorganized matter into the vessels. Pathologists have not sufficiently informed us upon this point. We prefer to consider it as only a subdued inflammation, and we are satisfied to know that we must substitute warm applications for cold, stimulating for depressing agents, simply because experience has taught us that it is best to do so. When the lessons of experience are so uniform, as in these cases, we can well afford to wait the slower developments of pathological science.

The condition of the living tissues, whatever it may be, now demands warm and stimulating applications, warm or even hot water, cataplasms or unguents containing turpentine or other resins, balsams, powdered cinchona, etc.

A new danger is from this moment added to those which previously existed. The disintegrating animal structures in a state of partial solution contain an active poison which taints the living issues upon which it reposes, and which, so long as it continues to bathe the open mouths of the veins and absorbents, is liable to be taken into the circulation, or at least to excite in them an irritation capable of

being propagated to every part of the body into which these vessels ramify.

In order to combat this danger it is necessary to remove the dead tissues as speedily as possible, especially those portions in which disintegration has fairly commenced. This we seek to accomplish by the forceps and scissors, clipping away all loose and hanging fillets, by a careful and diligent use of the syringe, and sometimes by warm water irrigations. In addition to these important measures, the value of which is too much overlooked, agents must be employed to neutralize the poisons which cannot be removed; these agents we call antiseptics, and the most valuable are chlorine in some of its forms, bromine, yeast, and charcoal.

As to amputation during the progress of traumatic gangrene, it is a remedy scarcely to be considered; or, it might be more proper to say, it is a remedy which seldom saves the life of the patient. In a very few cases we have removed the limb under these circumstances, and a complete recovery has followed; but the fact of recovery after an amputation implies a better condition of the general system than is usually found in persons suffering from progressive traumatic gangrene, and it is not entirely certain that such patients might not have recovered if the operation had been omitted.

CHAPTER XXII.

HOSPITAL GANGRENE.

(BY FRANK H. HAMILTON, JR., M.D., A. A. SURGEON U.S.A.)

HOSPITAL GANGRENE is the name given to a peculiar form of contagious phagedænic ulceration, whose causes, symptoms, pathology, diagnosis, prognosis, and treatment will form the subject of the present chapter.

CAUSES.—These are of two classes, namely, general or predisposing, and special or exciting. To briefly describe the former, we should simply mention all infringements of any well-known sanitary law; as including nearly, if not all, of the general influences favorable to the production of this disease. This, of course, comprises all errors in the location, ventilation, and police of institutions devoted to the care of a collection of sick and wounded; for it is only in an aggregation of cases that we ever meet with hospital gangrene.

Although overcrowding, bad ventilation, and want of cleanliness are too frequent causes of this form of phagedæna, still it is a well-known fact that severe and protracted epidemics of the disease have been inaugurated in hospitals whose locations were most healthful, and where all sanitary rules were obeyed with the utmost exactness. Such was the case at the De Camp and McDougall general hospitals, during the summer of 1863, then under the excellent management of Surgeons Simons and Bartholow U.S.A., respectively.

To the above must be added all those predisposing causes which may exist in the patient himself. For example, a patient with a scorbutic taint, an enfeebled constitution, or a nervous system depressed by the effects of a severe operation, or by the administration of chloroform, would, other things being equal, be more prone to contract hospital gangrene than his more robust comrade. This rule is, however, subject to exceptions, for I have repeatedly seen the disease attack the most healthy among a number of patients, leaving the anæmic and feeble untouched.

Some writers have claimed that certain seasons of the year were more favorable than others to the production of this disease. This statement has, I think, not been sustained by the observation of our army surgeons during the present war. It has prevailed in the hospitals at Nashville, Louisville, Murfreesboro', and elsewhere, at all seasons, and with an intensity more in proportion to the number of patients than to the time of year. For example, during the extreme cold of the winter of 1862–3, hospital gangrene suddenly made its appearance, under my personal observation, at the U.S.A. General Hospital, at Central Park, in this city. I am confident, however, that a very moist atmosphere has an injurious effect upon all suppurating wounds. I have repeatedly seen this illustrated in my wards at the McDougall General Hospital, where, on three different occasions, all the wounds under treatment put on an unhealthy action, many becoming gangrenous simultaneously, or nearly so; this occurrence evidently depending upon protracted periods of wet weather, which existed previous to each appearance of the unhealthy action in the wounds. This fact is easily explained, when we reflect that the probable cause of this form of ulceration is the presence in the

air of the products of putrefaction, and that a moist is more favorable than a dry atmosphere to the formation of this material. The fact that we meet with this disease in mid-winter, might seem to conflict with the theory that it is dependent upon the presence of putrefactive material in the atmosphere; this discrepancy, however, is easily explained, when we come to consider that the wards of a hospital may contain in winter air which, heated by artificial means and rendered moist by the exhalations of a damp cellar, or from other sources, may be equally productive of decay in animal tissues, as the air of the hottest summer months. The plant in the hot-house flourishes as well in winter as in summer, provided only the air from which it derives its nourishment is supplied with the necessary warmth and moisture. The patients in our hospitals are rarely exposed to the vicissitudes of the seasons, the air in the wards being carefully equalized at all times. Hence the air which surrounds a patient in winter is often more unwholesome than that which he respires in summer, for the reason that in winter ventilation is frequently omitted, in order to keep the air at a certain temperature; or, in other words, a quantitative analysis of a specimen of air taken from a room containing a number of suppurating wounds in winter, would reveal as large a quantity of the products of putrefaction present, as a similar analysis in the same locality in midsummer, provided that ventilation had been wholly, or even partly, sacrificed to warmth.

We now come to the consideration of the special or exciting causes. Of these, the most important are contagion and infection. No one now doubts that hospital gangrene is contagious. It can be conveyed from one individual to another by inoculation with the same certainty that attends the process of vaccination. Pouteau, a celebrated French

surgeon, at that time a dresser at the Hotel Dieu, accidentally inoculated a scratch upon his finger, while attending a case of this kind. Within a few days the characteristic slough had appeared, and was only arrested by the most active measures. The poison adheres with great tenacity to dressings, or other substances, once impregnated. Guthrie relates that some lint which had been used in these cases at Paris, was taken to Holland, having been previously thoroughly washed, dried, and bleached. When it came to be used in Holland, it was found to infect every wound or ulcer to which it was applied.

Hospital gangrene may be generated in a wound by rea son of the presence of any decomposing coagula or product of inflammation. It may owe its origin to the irritation caused by a spiculum of bone, a shred of lint, or other foreign substance; sudden exposure of the part to excessive cold, a hardened poultice, an acrid lotion, or a direct injury, can often be assigned as the exciting causes of this disease. The indiscriminate use of sponges, basins, and towels is, for obvious reasons, a fruitful source of hospital gangrene.

The disease is infectious; that is to say, it may be communicated from one person to another without the intervention of absolute contact. This fact has been indubitably settled by the evidence of a large number of clinical observations.

In a given case, we shall almost always find one or more of the local, combined with a variable number of the general causes enumerated, concerned in its production.

The type of the disease varies with the number, quality, and intensity of the general causes which are combined to produce and maintain the different epidemics.

The symptoms are both local and constitutional. The

former, being by far the more important, will claim our first attention.

Local Symptoms.—Hospital gangrene may attack a wound in any stage of its history, from the day of its receipt to a time when its cicatrix is nearly formed. It may attack an ulcer of any variety, from the highly inflamed ulcer, the result of a burn, to the indolent and intractable sore which we meet with in old and enfeebled patients. It may be the result of inoculation, and it may be generated where, to all appearances, there is no abrasion of even the cuticle.

In all instances, with the exception of the two last mentioned, the local appearances are very nearly uniform, and for the sake of convenience will be described under three classes, namely: those characterizing the periods of invasion, of full development, and of decline, respectively.

When hospital gangrene invades an open wound or sore, it first makes its appearance by dotting the part with blackish gray points, distributed at intervals over its surface. The healthy secretion of the part is suspended. The edges of the wound are livid, slightly raised and everted. The lividity of the edges extends a few lines, where it is met by a broad erysipelatous areola, showing capillary congestion and stagnation. There is discharged, at the same time, a small but variable quantity of a thin sanious fluid. The whole part now exhales a very offensive and penetrating odor. The above signs sufficiently characterize the stage of invasion, which occupies a period of from six to twenty-four hours. The grayish spots soon multiply and aggregate, completely covering the part with a pulpy tenacious mass, through which the ichorous fluid is being discharged in small quantities. The edges present a livid and sharply defined appearance. If not of a circular form, the circum-

ference represents a circle with the segments of smaller circles engrafted upon it. The slough, meeting with less resistance from the loose areolar tissue, burrows under the integuments, leaving, in some instances, a narrow portion only of sound skin bridging the excavation; more often, however, the ulceration extends only to the depth of a few lines beneath the skin, forming pouches, in which the débris of the slough are apt to accumulate. Sometimes the gangrenous slough is projected from the surrounding tissues, presenting the appearance of a fungoid growth. In cases of this variety, however, the mass is soon levelled down by the rapacious ulcer, and presents the usual excavated appearance, unless, as I have seen, the disease be arrested while the slough is still in this position.

When hospital gangrene invades the track of a ball it frequently occasions large excavations underneath the skin and other tissues, out of sight, which will, unless the surgeon is forewarned by experience, escape his observation, until suddenly the skin, which has already become discolored, gives way and reveals an extensive gangrenous cavity, with the tendons, vessels, and nerves, perhaps, cleanly dissected, and stretched across from side to side.

Should it make a successful attack upon the muscular structure, we may see shreds of this fibre eroded and depending from the slough. The mass evolves a penetrating stench, which needs only to be perceived to be recognised. The phagedæna now rapidly extends in all directions, but particularly in the direction of the cellular planes. Thus I have seen the muscles of the lower extremities exposed for a width of four inches, and from the trochanter to the malleolus, as the result of a slough of this character. The disease occasionally extends to the bone itself, producing extensive caries.

A wound presenting these appearances might be said to be in the stage of full development of hospital gangrene. Each new case, however, may present some peculiarities and anomalies in its minute appearances, which are to be learned from experience more than from any description which can be given.

The gangrene now progresses rapidly, unless arrested. I found the average duration of the disease during an epidemic occurring under my observation, to be sixteen days; but it is not to be expected that an average based upon any other set of cases would correspond precisely with this, inasmuch as the disease is not self-limited, and its duration depends entirely upon the success of the treatment adopted.

In case our treatment is successful, the stage of decline is soon ushered in. This is characterized by a sudden and complete evolution of the slough, revealing the bright healthy granulations which rapidly repair the injury; or the surface presented is simply muscular fibre, smooth, red, destitute of covering of any kind, and without secretion or granulation.

When hospital gangrene attacks an unbroken surface it generally appears as a vesicle. This soon breaks, discharges a thin sanious fluid, and leaves a surface covered with the characteristic slough. It is sometimes first noticed as a bluish spot upon the integument. Although differing in their primary appearances, these varieties assume the character of the former and more common class, as soon as there is an open surface exposed. After the slough has once made its appearance, no matter what may have been the character of its origin, the history of its subsequent development is uniform with that which has been described as belonging to the first variety mentioned.

Constitutional Symptoms.—These are in general conceded to be in a great measure dependent upon the local difficulty. They consist chiefly of pain, loss of appetite, great exhaustion, febrile action, diarrhœa, and sometimes delirium. Dr. M. Goldsmith, Surgeon, U.S.V., a gentleman whose experience and research in this disease render his opinion of great weight, makes the following statement as the result of his observations:—"The disease could in no case be said to have a constitutional origin. In no case did the constitutional symptoms precede the local disease, or continue after the gangrene had been arrested." My own experience fully confirms the truth of this observation.

The pain, when present, is described by the sufferer as gnawing and biting, and is sometimes very excruciating.

The patient generally loses his appetite at the outset of the disease, and does not recover it until the sloughing is finally arrested.

Fever is by no means a uniform symptom, but, when noticed, is marked by a frequent thready pulse, insomnia, and sometimes delirium. It always partakes of the asthenic or typhoid type, and demands stimulants and nourishing diet.

Pathology.—There is no certain knowledge in regard to the pathology of hospital gangrene. Clinical observations have pointed to the fact that the malady is, in the first instance, local, and that the constitutional symptoms are in a great measure dependent upon the fact that some part, either of the products of the sloughing process or of the original morbific material, is absorbed or introduced from the affected part into the general system. The occurrence of pyæmia and the great constitutional disturbances which are the frequent accompaniments of this disease, plainly confirm this observation.

I am convinced that hospital gangrene can be generated, *de novo*, only where there is a number of suppurating wounds in close relation to each other. That under these circumstances, the peculiar poison or fomites is produced. What is the nature of this poison, and upon what it depends for its peculiar power, we are as yet ignorant. Microscopical examinations of the slough reveal the débris of tissues, but no peculiar living organisms. Dr. J. J. Woodward, U. S. Army, writes to the Surgeon-General, that a microscopic examination of the slough failed to reveal "any cryptogamic organisms, except the ordinary vibrios, which are to be observed in every decomposing animal substance."

The pathological relations of hospital gangrene to diphtheria, erysipelas, pyæmia, and gangrenous scarlatina, have been the subject of much research and discussion. The point is, however, far from being settled, and possesses but little value in a practical point of view.

Diagnosis.—Keeping in mind the marked character of the slough, and a few of the more prominent of the local symptoms, we will rarely fail to distinguish hospital gangrene from any of the common forms of phagedænic ulceration or erysipelatous inflammation. The disease has few, if any, of the characteristics of either form of common gangrene, and hence will never be confounded with them.

Prognosis.—In 1787, Pouteau wrote that public hospitals had better be abandoned, inasmuch as the frequent occurrence in them of hospital gangrene had rendered them rather a scourge than a benefit to humanity. In 1813, however, an entire revolution of feeling on this point took place, by reason of the introduction of local caustic applications in the treatment of these cases, by which means

they were transformed into comparatively harmless occurrences. I am confident that, if the statistics of all the U.S. Army Hospitals in reference to this disease were to be collected, the mortality shown would be considerably less than five per cent. Such a result would contrast remarkably with the statistics furnished by the campaign on the Spanish Peninsula in 1813, where out of 1614 cases, 520, or nearly one-third, proved fatal. The treatment relied upon at that time consisted in bloodletting and the administration of mercurials.

TREATMENT.—The treatment of hospital gangrene naturally divides itself into prophylactic, constitutional, and local.

The prophylactic treatment consists in the avoidance of all the general and specific causes which are known to be in any way concerned in the production of this disease, and in the use of disinfectant agents in the management of any aggregated number of suppurating wounds, a bountiful supply of wholesome air, a rigid system of police, and a nutritious diet.

The proper location of sinks in relation to the hospital wards, and the free use of the chloride of lime or of some other disinfectant in them when they are necessarily placed in close juxtaposition to a ward, are matters also of vital importance.

In the dressing of wounds great care should be exercised to keep them free from any accumulation of pus or of coagulated blood, and to remove immediately to a distance, or what is better, burn all lint, bandages, or other dressings, as soon as they have been taken off from a suppurating surface. Their presence in the wards, for a few hours only, may be sufficient to produce hospital gangrene. In short, a reference to the enumeration of the general and local

causes will give a ready key to the subject of the prophylactic treatment of this disease.

I believe that there is now but one opinion in regard to the means to be adopted in combating the constitutional symptoms presented during the rise, progress, and decline of hospital gangrene. No one now thinks of recommending bleeding, or depletion by any method, or at any stage. Experience has established the rule that the patient must be sustained from the first period of the disease to the last. Wine, porter, and other permanent and diffusible stimulants are generally used, in conjunction with iron, quinia, and beef-tea. As to the quantity and kind of alcoholic stimulants to be given in a certain case, this must be decided by the previous habits, by the taste, and by the inclination of the patient. I have found that strong milk-punch, made either of brandy or whiskey, is by far the most agreeable and efficient mode of administering stimulants in a large majority of cases. In case beef-tea or beef-essence is not relished by the patient, eggs and other nutritious food should be substituted.

We now come to the most important part of the treatment, namely, the local applications. These are many, and vary in simplicity of preparation from the actual cautery to the elegant combinations of the permanganates and bromine. We will not attempt to enumerate the more obsolete of the local applications, but refer more particularly and minutely to those which the clinical experience of comparatively recent dates has proved to be the most efficacious. Nitric acid has been used with some success, both in a pure state and diluted. Creasote, pyroligneous and strong acetic acids have been advised by some. Nitrate of silver has sometimes been successful in arresting the progress of the sloughing. My own experience has convinced

me of the superiority of bromine over any other preparation as a local application in hospital gangrene. We are indebted to Dr. M. Goldsmith, Surg., U.S.V., for the introduction of this valuable agent. In order to obtain the full and complete effects of bromine, it should be applied carefully and thoroughly. The following practical hints, suggested by Dr. Goldsmith, most of which have been confirmed by my own experience, should be observed in the application of this agent:—

1st. If the operation promises to be a painful and tedious one, Dr. Goldsmith advises that the patient be rendered insensible by the use of an anæsthetic. This I consider of doubtful propriety, inasmuch as I regard the depressing influence of chloroform as a predisposing cause of the disease.

2d. The wound, having been carefully cleansed by thorough sponging with warm water and soap, should be freed from all dead and gangrenous tissue by means of a scalpel or scissors, aided by the forceps. The healthy tissue should be denuded as far as possible.

3d. The surface to be treated should now be thoroughly freed from moisture. This is most readily done with a swab of lint on the end of a probe, with which the surface is carefully dried. Do not omit to penetrate the pouches and recesses.

4th. If the pure bromine be used, a small glass pipette should be introduced into the bottle containing the liquid, and then, being carried to the surface to be cauterized, thoroughly applied to every part. Cavities may be reached by means of small portions of lint dipped in the bromine, and then carried by means of an eyed probe, or a pair of forceps, into the desired positions.

5th. It is frequently beneficial to paint the surrounding

tissues to the extent of an inch, perhaps, with a solution of the bromine; using a drachm of the bromine in four ounces of water.

6th. Immediately after the application of the bromine an emollient poultice should be applied. This tends to allay any undue irritation, and favors the speedy evolution of the slough.

There are three different preparations of bromine which have been employed. Dr. Goldsmith first employed a solution of the bromide of potassium and bromine, or the compound solution. After using this for some time, he at length resorted to the pure brominium, and very soon arrived at the conclusion that this was the only form in which it should be used. I have used both the compound solution and the pure bromine, and do not hesitate to express my preference for the latter article. I have also used a dilute solution of the pure bromine, in the proportion of a drachm to eight ounces of water, with great benefit, as a disinfectant and prophylactic dressing to be applied to unhealthy-looking wounds.

After having carefully applied bromine to a case of gangrene, we find that the part smells perfectly sweet and clean. If there is any trace of the odor remaining, we may be sure that our application has not been thorough.

The fumes of bromine, given off as a dense red vapor when a bottle of this liquid is unstoppered, furnish us with an invaluable diffusible deodorizer in wards where the emanations of a large number of suppurating wounds render the atmosphere fœtid.

The permanganate of potassa is scarcely inferior as a local application in this disease. Dr. Hinkle, Act. Assist. Surg. U.S.A., has the honor of having first introduced this valuable agent to the notice of the profession. Dr. Hinkle

also recommends that the salt shall be given internally in the form of a solution, giving from one to three grains every twenty-four hours. He attributes to it the power of "a tonic astringent, an oxygenator, and vivifier of the blood." "Locally," I quote his words, "the concentrated solution was applied as an escharotic, with a hair pencil, over the surface of the wound, even extending its application over the cuticle four inches beyond the seat of the wound. After the wound was carefully pencilled, lint, saturated with the dilute solution, was applied, and the dressings repeated every three or four hours." The "permanganate salts," or "disinfectant," is now supplied by the U.S.A. Med. Department. The liquid is of a purplish-black hue, and very dense. The bottle containing the substance is supplied with a label giving full directions for use.

Maunsell's solution of the persulphate of iron has also been recommended, and clinical experience has shown it to be a valuable agent in the treatment of this disease. When we have not other means at our command, we may employ the pure tincture of iodine, applying it to the surface with a camel's-hair pencil; and with confidence that we shall thus arrest the disease, but perhaps much more slowly than with some other remedies.

Dr. Hachenberg, A. A. Surg. U.S.A., has recently recommended the use of spirits of turpentine. He advises that it should be applied thoroughly every three hours. Dr. H. claims that this remedy possesses a superiority over most of the others in use, on the following grounds: "1st. Its permeability. 2d. It is a ready solvent of the broken-down adipose tissue of the wound. 3d. It has local alterative, stimulating, and sedative effects. 4th. Its anti-zymotic properties. 5th. It is antiseptic and styptic. 6th. It is non-escharotic in its effects. It causes no immediate or

chemical eschar, as do bromine, nitric acid, and some other remedies, which are often the means, unhappily, of the retention of vitiated secretion in the wound."

The rules suggested for the application of bromine and potassa are equally applicable to any of the agents which may be employed. The efficacy of the remedy depends, in a great measure, upon the care and completeness with which it is applied.

The following is a statement of cases which occurred at the McDougall General Hospital during the summer of 1863, and illustrate, to some extent, the comparative efficiency of the different agents employed. The solution of bromine referred to, was one drachm of the pure bromine to eight ounces of water, and was not the "compound solution" first used by Dr. Goldsmith. Subsequent to the preparation of these tables, having had a personal interview with Dr. Goldsmith, I began using the pure bromine, and with much better effect than I had experienced with the solution.

Whole number of cases treated, 33.

Of these but two were attended with fatal results, and these some days after the gangrene had been arrested. In one case the patient died from exhaustion, the result of extensive suppuration in the knee-joint, the wound having been in perfectly healthy condition for several days. In the other case the patient died from dysentery, his wound having put on a healthy action two weeks before his decease.

In one case, where nitric acid was used, the disease was not arrested, and at the end of ten days it was found necessary to amputate the leg above the knee. The stump healed by the first intention. The average duration of all the cases under all treatments amounts to 12.1515 days.

Number treated with nitric acid, . .	18.
Average duration of disease, . . .	16 days.
Number treated with sol. bromine, .	14.
Average duration, ...	6.6428 days.
Number treated with iodine, . . .	1.
Average duration, ...	7 days.

The cases were under the care of Drs. Caldwell, Peck, Graves, and myself, respectively, and the sanitary surroundings were as nearly similar as could be possible. We were all agreed upon the constitutional treatment, which consisted in good diet, whiskey, and iron. The figures show strongly in favor of the use of bromine.

GENERAL REMARKS.

Amputations performed during the progress of hospital gangrene are, as a general rule, disastrous, for the following reasons: The patient is in no condition to rally from the effects of the operation, and the stump is exceedingly liable to be attacked with the disease for the arrest of which the operation was performed. Exceptions to this rule are rare.

The ligation of arteries is sometimes demanded and should always be performed, without reference to the probability of the disease again attacking the artery. Dr. George R. Weeks, Surg. U.S.V., makes the following remarks in this connection: "I have tied the anterior tibial artery upon the face of a gangrenous stump, and arrested the process by the use of bromine, and the patient recovered as well as by a primary operation. The brachial and dorsalis pedis artery were tied under the same circumstances, with the same result."

CHAPTER XXIII.

DRY GANGRENE.

It is thought proper to consider briefly in this connexion a species of gangrene which is seldom, if ever, a result of gunshot injuries, but which is nevertheless now and then met with in army practice.

Dry gangrene commences usually in the lower extremities, attacking first the toes; much less frequently it commences in the fingers; occasionally upon the nose; or it may make its appearance upon any point of the surface of the body, but it is almost constantly seen to prefer those parts of the body which are remote from the heart, and where the circulation is naturally feeble.

Dr. Welles, of Wyoming Co., N. Y., related to us some years since the case of a girl aged ten years, who, a few weeks after an attack of scarlatina, became anæmic, pale, and somewhat dropsical. About this time a purple spot appeared upon her right cheek, over the malar bone, surrounded by a lurid circle; the spot gradually assumed a russet color, then became dry and mummified; it itched occasionally along the margin, but was never painful. She rapidly declined in health, and when the gangrene had extended about one inch and a half, she died.

In some cases the death is preceded by pain, swelling, and redness; the pain being usually of a burning character, and the redness being of a dark color, like that which is present in erysipelas. In other cases the patients

complain of severe, lancinating pains, but no swelling or discoloration precedes the death. In still other examples there are no premonitory signs of the approach of death in the part, but the attention of the patient is first arrested by the black discoloration.

As the disease progresses, if in the foot, it gradually extends from one toe to another, and upwards towards the body; the parts which are dead becoming dry, black, and shrunken. A slight redness, with some swelling, usually precedes the gangrene in its progress up the limb, and sometimes dark-red or purple lines indicate the course of the superficial veins and absorbents.

In the case of the lower extremities, the limb separates spontaneously in most cases, by the arrest of the gangrene, and the occurrence of healthy suppuration, near the ankle-joint, or at least by the time the death has reached the middle or upper part of the leg; the soft parts falling away from the bone at these points by the supervention of moist gangrene, leaving the bone to be subsequently exfoliated, or to be removed by the saw, or possibly to be separated at the joints.

Constitutional symptoms, generally characterized especially by exhaustion, sometimes precede the occurrence of dry gangrene, but by no means constantly. As the disease progresses, however, symptoms of exhaustion are rarely absent, and in some cases the patients die in a condition of low delirium.

The prognosis is in most cases unfavorable, but this will be modified greatly by the condition of the patient, and the cause of the gangrene.

In general the cause may be stated as anything which arrests arterial circulation. If only the venous circulation is arrested, the death which results will be followed by

rapid decomposition, constituting moist gangrene; if both the venous and arterial circulation is arrested the same result will generally follow, but not invariably; but if the arterial circulation alone is restrained, while the blood is permitted to return freely by the veins, the parts become so much drained of their natural moisture that in many cases only dry gangrene can result.

This is probably the simple theory of its causation in all cases, but the modes by which parts of the body may be defrauded of their natural supply of arterial blood are various. It may be in consequence of diminished action of the heart, as a result of disease of the heart itself, or of an enfeebled condition of the whole system. It is not uncommon as a result of typhus or of typhoid fevers. During the past winter we have seen in our service at the Island Hospital an example of this kind in a woman aged twenty-eight, convalescing from typhus. The death commenced simultaneously in both feet and extended to the middle of both legs. Before death it presented itself, also, upon the extremity of the nose. Both limbs separated spontaneously, and she lived after the commencement of the gangrene, two months. It may be occasioned by the formation of an aneurism in the course of the main artery, or by the pressure of a tumor; twice we have produced dry gangrene by the ligature of an artery, once after tying the femoral and once after tying the external iliac; we have seen and reported one example in the foot occasioned by the pressure of a broken femur against the popliteal artery, and we have seen two examples in which we had reasons to believe that the pressure of a broken humerus upon the brachial artery has produced a like result. Boyer and Gibson have both recorded similar instances.

In two of the examples above enumerated, namely, in

the case where this condition was a result of ligature of the external iliac, and in the case in which it was caused by pressure of the broken femur against the popliteal artery, the gangrene was at first white; the parts being dead and shrivelled for some days before the discoloration took place.

In the April number of the American Journal of Medical Sciences, for the year 1835, is recorded an example of white dry gangrene which was presented at the Hotel Dieu in Paris. It existed in both the fingers and toes of a man forty years of age.

Dupuytren affirmed that in all cases arteritis must be regarded as the cause of dry gangrene. Prof. Benjamin McCready of this city relates in the May No. for 1836 of the same journal, one case in point, and refers to several others seen by Prof. Valentine Mott; Gibson mentions a case evidently due to arteritis; and we have seen ourselves several examples of this kind, three of which have come under our observation during the last winter in the New York and Brooklyn Hospitals. When it occurs as the result of arteritis, it is generally observed that the persons so affected are advanced in life, and the autopsy reveals an ossification, or a calcareous or atheromatous degeneration of the arterial coats, with a more or less complete occlusion of the vessels by fibrinous or other deposits.

Many years since, M. Tessier, by request of the Royal Society of Medicine of Paris, instituted certain experiments which established beyond farther controversy the fact that ergot was capable of producing this affection, and that this was its most common cause in various parts of France, Switzerland, and Germany where damaged rye was much eaten. Subsequent facts have still farther confirmed these observations. Whether the ergot produces its specific

effects by inducing arteritis or in some other manner, has not been so clearly established.

In the month of Sept. 1862, we were permitted to see in the Armory Square Hospital, Washington, D. C., under the charge of Surgeon Bliss, U.S.V., nine examples of dry gangrene in soldiers, belonging to the army of the Potomac, which were manifestly the result of a scorbutic taint. The men who were thus attacked were all of them new recruits, and most of them were quite young. They were New England boys, brought from farming districts, and had been in the service only about three months; during this time they had been subjected to no particular hardships either in marching, fighting, or exposures to inclement weather. No fevers or other sickness had preceded the attacks. In no instance were the men able to assign any cause; but upon inquiry we ascertained that during these three months they had been confined almost entirely to either salt or fresh meat and hard bread.

The death had assailed both fingers and toes; and in most of the examples it was arrested after having involved one or two joints. We believe that not one of them died.

The surgeon in charge entertained the same view of these cases with the writer, and the constitutional treatment consisted mainly in the liberal use of vegetables and other anti-scorbutics.

It may be regarded as singular, and perhaps as somewhat inconsistent with the explanation we have offered, that, among all the cases of scorbutus which we have seen in the U. S. Army, and especially in the western armies, no other examples of dry gangrene have come under our notice; but perhaps it may be found that in some respects the condition of these troops was peculiar. They came from rural districts, and had all their lives been accustomed to an

abundance of potatoes and other vegetables, with milk, butter, fresh bread, etc., and of all these they had been at once and for months deprived. In short, the change was more extreme and sudden than usual.

Treatment.—Dupuytren, who, as we have seen, held that arteritis was the sole cause of dry gangrene, recommended bleeding and other depletant measures, and he has cited illustrations to prove the correctness of these therapeutical views. McCready, Gibson, and others, have confirmed the value of this treatment in certain similar cases. It must be understood, however, that the arterial obstructions which determine the local gangrene, are, in many cases, especially in old persons, the results of an extremely chronic form of arteritis, if indeed that ought to be called arteritis at all which is unaccompanied with any of the usual signs of inflammation, and which can only be recognised by the morbid results found in the post-mortem examination.

If nevertheless we admit, in conformity with the views of modern pathologists, that the calcareous and atheromatous degenerations of the vessels are due to a chronic inflammation, it by no means follows that bleeding must be the proper remedy. Chronic inflammations seldom yield to depletion; and, moreover, the gangrene is a consequence of the results of inflammation rather than of the inflammation itself. It is a consequence of the morbid deposits, and may not commence until after the inflammation has wholly ceased, and perhaps not until advancing years have still farther exhausted the contractile power of the heart. Numerous clinical observations establish the fact that bleeding is not serviceable in a large proportion of these cases. It can, indeed, only be employed with propriety in well-marked cases of acute or subacute arteritis.

Generally these cases demand stimulants given pretty freely, as an internal remedy; with the tolerably free use of opium, when pain, restlessness, and watchfulness indicate its necessity.

In case the disease is due to a scorbutic taint, the employment of nourishing and anti-scorbutic food is plainly demanded.

As local remedies, in most cases we employ the usual stimulating and disinfecting agents; applying them only to the living tissues and the parts which are beginning to disintegrate, and not to the portions which are dry. Indeed, it must be remembered that moist applications will soon convert the entire mass of dried tissues into moist gangrene, and without serving any useful purpose, will render them much more offensive. Occasionally, especially when the gangrene is due to acute arteritis, nothing but cool applications can be tolerated.

Dupuytren thought that amputation, while the disease was in progress, could never be justified. Valentine Mott has reported three cases in which he amputated before the line of demarcation was formed. Of these only one finally recovered. Of the remaining two, one died on the fourteenth day after the operation, and one died of dysentery some months after.* Gibson's patient, whose leg was amputated under the same circumstances, died also.

During the present year one double amputation (of both legs) has been made at Bellevue Hospital, and one single at the Long Island College Hospital for dry gangrene while the disease was in progress, and both patients have died; but in the same time four have died of the same disease whose limbs were left to separate spontaneously; and one

* Amer. Jour. Med. Sci., May, 1836.

case is now in progress under our care, which, without amputation, will probably make a complete recovery; but the disease, commencing in the toes, was arrested spontaneously before reaching the foot.

It is our impression that it will be found seldom if ever advantageous to amputate while the disease is in progress, from whatever cause it may have originated; and especially if it is dependent upon any general or constitutional causes, upon arteritis, or upon the use of ergot.

When the line of separation is well formed, or is completed, the surgeon will be governed by the circumstances, and especially by the condition of the patient and the rapidity with which the spontaneous separation is being accomplished. In most cases he will find it best to leave the amputation altogether to nature. In the case to which we have already referred as occurring from ligature of the external iliac, we amputated the thigh after separation had commenced, and the patient recovered. In the case produced by ligature of the femoral artery, the amputation made under the same circumstances resulted in death.

CHAPTER XXIV.

TETANUS.

THERE are two forms of this malady, differing more in their mode of causation than in the symptoms by which they are characterized. They have been named Idiopathic and Traumatic.

Idiopathic tetanus is that form which arises from general, constitutional, or internal causes, and has no dependence upon a wound or external injury. These causes are substantially the same with those which, when found to precede or accompany traumatic tetanus, are called "predisposing." Among them have been enumerated cold, dampness, heat, and dysentery. It has been known to be occasioned by gastritis, intestinal ulcerations, a hernia, pericarditis, a pulmonary abscess, disease of the mammæ, uterine irritation, an emetic, nux vomica, cicuta, and various other acrid poisons.

There is a variety of idiopathic tetanus, also, called Trismus nascentium, Trismus Infantum, or "nine day fits," which is common and exceedingly fatal in the West India Islands and in the Southern States of our confederacy, especially among the negro children. In the rocky Vestmann Islands, on the south coast of Iceland, with a population of only one hundred and fifty persons, one hundred and eighty-six infants perished from this cause in the space of twenty-five years. Dr. Joseph Clark says that in the year 1782, of 17,550 children born in the Lying-in Hospital of

Dublin, 2,944 died from this cause alone within the first fortnight after birth. Its most frequent causes are insufficient or unwholesome milk, filth, and exposure to inclement weather. We have seen it occasioned in one instance by a dose of castor oil. It is said also to be produced sometimes by injury sustained in the ligation of the umbilical cord. These latter examples must be regarded as traumatic.

Traumatic tetanus, or that which originates directly from a wound, is divided into acute and chronic. The former is much the most frequent. It might be more proper to regard these two forms as only different degrees of the same malady.

The causes of traumatic tetanus are predisposing and exciting.

The predisposing causes are mental depression, climacteric influences, such as excessive heat, sudden vicissitudes of weather, and especially a rapid change from hot to cold and damp weather—it is more frequent in spring and autumn than in summer or winter—exposure of a portion of the body to cold drafts of air, an irritable temperament, physical exhaustion, disorder of the stomach or bowels, a scorbutic taint, etc., etc.

The exciting causes are wounds, especially compound fractures, in which spicula of bone press upon nervous trunks; wounds accompanied with unhealthy suppuration; gangrenous sores, or those which from neglect are not kept properly cleansed; laceration, contusion, partial division, or the ligation of a nerve.

It has been known to be occasioned by cutting a nail or a corn too closely, by stubbing the toe, by abrasion from wearing tight boots, by a wound of the gums, by a laceration of the fourchette in labor, by the sting of bees, by the

stroke of a schoolmaster's ferule, by salivation, the introduction of a seton, the injection of a hydrocele, the lodgment of a fish-bone in the fauces, the application of a scarificator in cupping, the ligature of arteries, ligature of the umbilical cord, burns, the excision of tumors.

In one instance we have known chronic traumatic tetanus occasioned by the prick of a needle.

Gross observes that the effect of cold air in the production of tetanus is well illustrated by an occurrence which took place after the battle of Ticonderoga, in 1758. The wounded were exposed the whole night after the action in open boats upon Lake George, and the consequence was that nine of them died of this disease. During the war of 1812 "most of those wounded by fire-arms on board the frigate Amazon, before Charleston, were attacked with tetanus on the fourteenth day;" the weather, which had been warm and dry, having changed suddenly to cold and wet.

Dr. Miner of Buffalo, in a paper on Tetanus,* informs us that, according to the U. S. Census returns of 1850, the recorded examples of tetanus in the several States during the ten preceding years, presented the following remarkable contrasts: In the 6 New England States, 19 cases; New York State, 23—total 42. While in the Southern tier of States lying adjacent to the Gulf of Mexico and to the mouths of the Mississippi, 23 occurred in Georgia; 6 in Alabama; 60 in Mississippi; and 215 in Louisiana. "Of the whole number in the United States, 694, there were 367 among children under one year of age, this including the negro children who die of trismus nascentium."

The period of incubation, or the period which elapses between the receipt of the injury and the invasion of the disease varies from a few hours to several weeks, but its

* Miner on Tetanus, Buffalo Med. Jour., March, 1859.

most common period of invasion is from the third or fourth to the 22d day. Sir James McGregor says it never appears after the twenty-second day, but several cases on record prove the incorrectness of this statement.

The premonitory symptoms are rarely of a character so definite or peculiar as to indicate plainly the accession of this malady. In some cases the unhealthy appearance of the wound, increased pain, twitchings of the muscles, mental depression, wakefulness, and a general *malaise*, might awaken a suspicion; but these circumstances, so common in the history of most severe injuries, could not properly be relied upon as indications of the approach of a complication so exceedingly rare.

The symptoms which characterize its actual accession are fugitive pains and stiffness about the muscles of the face and neck, observed first, in most cases, upon the side corresponding to the wound. The patient is unable to open his mouth freely, the angles of the mouth and eyes are drawn aside, he swallows with some difficulty, especially fluids, and the muscles of mastication are rigid.

When the disease has progressed no farther than this it is called Trismus or Lock-jaw, and in mild cases it is sometimes arrested at this stage.

More often, however, the disease steadily advances; a severe and fixed pain shoots from the ensiform cartilage to the back, accompanied with difficult and convulsive breathing, in which the muscles of the glottis are also implicated; the walls of the abdomen are hard, the bowels constipated; urination is difficult. Sooner or later all the muscles of the body become rigid, constituting true tetanus; or the muscles of the back being most violently contracted, the patient rests only upon his head and heels, a form of spasmodic contraction which is termed opisthotonos; more

rarely the incurvation takes place in the opposite direction, constituting emprosthotonos; and still less frequently a lateral incurvation is observed, which has been called pleurosthotonos.

In well formed cases these spasms may occasionally relax, but they never completely cease. The pupils are contracted, froth escapes from the mouth, while the teeth remain firmly closed; and in the distorted features agony, pain, and despair alternate with sardonic smiles. Obstinate and persistent constipation is invariably present.

The pulse, except when accelerated by the violence of the spasms, remains undisturbed. But the most appalling circumstance of all is the fact that, during this frightful agitation of the body, the functions of the brain are generally unimpaired, and, like a mariner in the midst of a storm, the mind of the sufferer is the conscious witness of the writhing and tossing of the vessel whose speedy wreck seems inevitable.

As the case approaches a fatal termination the paroxysms become more frequent and violent, and the breathing more embarrassed, until at length the patient dies in a state of exhaustion or of suffocation.

Death generally takes place on the third or fourth day, sometimes as late as the eighth, tenth, or twelfth day; but if life is prolonged beyond this, recovery may be generally anticipated. Occasionally it has been observed that the spasms commence, and are throughout more violent upon the side corresponding to the wound; and still more frequently it is noticed that in the early stages the spasms are confined to the muscles in the neighborhood of the wound.

The prognosis in these cases is always exceedingly unfavorable. Hennen says he has never witnessed a cure of acute traumatic tetanus, but in some examples of the chronic form he has seen a relief accomplished. The distinction

made by Hennen and others between the acute and chronic forms is, as we have before intimated, arbitrary and unnecessary. They constitute, in our opinion, degrees of the same malady; and to judge of the curability of the affection, we must consider them as one.

Of 23 cases reported and tabulated by McLeod as having occurred in the Crimea, 2 recovered. In the records of the army in India, McLeod found 19 cases, of whom 1 recovered. Alcock reports 17 cases, of whom 2 recovered. In the Egyptian campaign reference is made to more than 30 cases; "all seem to have died within a week of the appearance of the symptoms." In the German campaign "several are recorded as having recovered after section of the nerve."

No public statement has yet been given of the number of cases which have occurred during our present war, nor of their results. We are informed, however, unofficially, that the number reported to the Medical Bureau at Washington is not far from 150; and that with but few exceptions the cases have proved fatal.

We have met with eight cases, assuming the form of trismus or of fully developed tetanus, and of these three have recovered.

The examples of recovery were as follows:

June 5th, 1835, a healthy girl was stabbed with a pair of long shears, wounding the median nerve of the forearm and the walls of the chest. She had well developed trismus on the following day. We administered Dover's powders in full doses, and at short intervals. Apprehending an internal hæmorrhage, from the wound in the chest, she was bled from the arm once, but only to a small amount. In twenty-four hours the trismus abated, and in about one week it had entirely ceased.

Mrs. C., the wife of a physician living in Painesville, Ohio, aged sixty years, pricked her thumb with a needle in May, 1858, and about two months after, the finger having become exceedingly tender and painful, she was attacked with trismus. Four months after the receipt of the injury, at which time we were consulted, the trismus continued unabated.

She was cured finally by the use of tonics alone; the disease having lasted at least four or five months.

Mr. Harris of Buffalo, æt. forty-five, received a lacerated wound of his hand, March 2, 1858. The bones were not broken. On the sixteenth day a slight trismus was observed. The wound was open. We saw him on the second day of the disease, in consultation with Dr. Miner. The tetanus was then well developed. On the eighth day it had reached its acme, the spasms assuming the form of opisthotonos. On the eleventh day he began slowly to improve, and at the end of thirty-one days the spasms occurred only at long intervals. A fragment of necrosed bone was now removed, and from this time the recovery was rapid. Five weeks from the period of the accession of the malady he was entirely well.

In this case the tetanus began when the finger commenced to swell, giving indications of the presence of disease of the bone. Its subsidence dates from the occurrence of free suppuration, and its rapid cure from the removal of the necrosed bone. The general treatment consisted in the free use of stimulants, nourishing diet, and opiates; but he seemed to experience most relief from injections *per rectum* of the acetate of morphia, two grains being administered every four hours during many days.

In the following examples which have been brought under our immediate notice, death has been the result:

S. J. M., of Buffalo, æt. thirty-five, received a fracture of

his arm and a severe lacerated wound of his thigh. On the twelfth day tetanic symptoms were announced, and he died on the twenty-second day—ten days after the accession of the disease. The treatment consisted mainly in the use of stimulants and sedatives, but neither were employed very freely. The autopsy disclosed a pointed fragment of the humerus penetrating the tissues, but no nerve was immediately involved. The anterior crural nerve and the internal saphenous nerves of the thigh had suffered injury.

A healthy lad, aged ten years, fell from a tree April 22, 1856, breaking both bones of his right forearm below its middle. The arm was dressed in the usual manner by the surgeon in attendance. On the fifth day tetanus commenced. We saw him on the morning of the sixth day. He had already taken morphine freely. We administered chloroform, which relieved his suffering; but he died at half-past twelve, having survived the occurrence of the disease less than twenty-four hours. The examination after death disclosed the fact that a point of the broken ulna was pressing against the ulnar nerve.

A lad, æt. 13, fell and broke his right leg, near its middle, Nov. 15, 1860. The fracture was nearly transverse; so we are informed by his surgeon, Dr. Mason of Brooklyn. It was easily reduced. On the eighth day, after some changes carefully made in the dressings, the tetanic symptoms were first presented. We saw him on the ninth day of the disease, and he died on the tenth day; having survived the accident eighteen days. The remedies employed throughout were mostly large doses of assafœtida, and McMunn's Elixir of Opium. These agents gave him much relief at first, but finally proved of no avail.

A healthy laborer, æt. forty-one, injured one of his fingers June 23, 1860. He was received into the Long Island

College Hospital, and one of the House Surgeons amputated at the second joint. The wound did not heal kindly, and on the thirteenth day after the original injury tetanus commenced. Dr. Dodge, the attending surgeon, gave him Cannabis Indica freely. In our capacity as Surgeon-in-Chief of the hospital, we saw him in consultation with Dr. Dodge one or two days later. He was then very fully under the influence of the remedy; being rather inclined to sleep, and the tetanic symptoms having abated. The medicine was continued, but within a day or two from this time the disease recurred with increased severity, and he died.

E. D. P., æt. thirty-seven, a private soldier, of good constitution, was admitted to the McDougall General Hospital, May 10, 1864. He had received a gunshot wound in the left arm, near the wrist, April 31, 1864, breaking the ulna. He was brought from the "White House," on York river, Va., in a transport. The wound was doing well when he was put on the boat. He was thirty-six hours on the passage, and during this time the wound was attacked with hospital gangrene; and when he arrived at the hospital, trismus was also developed.

The ward surgeon gave him immediately half a grain of morphine.

On the following day he received three grains of morphine, the tetanic symptoms still progressing.

Third day.—In addition to full doses of morphine, the surgeon administered, by inhalation, chloroform every half hour.

Fourth day.—By courtesy of the surgeon, Dr. Earle, we were permitted to see the patient. Patient complaining of great pain in the back of his neck. Mind perfectly clear. Wound gangrenous. Has frequent twitchings of the mus-

cles of the forearm when the general convulsions are absent; trismus persistent. While standing beside the bed a violent opisthonic convulsion occurred, which the chloroform soon controlled.

It was our opinion that the broken ulna was goading the ulnar nerve, and we recommended amputation. This was practised on the following day, but with no relief. He died on the sixth day of the disease.

Treatment.—The local treatment consists in the removal, as far as possible, of the local irritation, in case any such irritation is found to exist. If the wound is suppurating, the matter must be allowed free exit; and all ichorous discharges should be corrected by antiseptics, or by the free use of tepid water. Gangrenous sloughs should be treated, with reference to their causes, upon the general principles already discussed. All foreign bodies presumed to be sources of irritation must be carefully sought for and removed, whether they be fragments of dead bone, bullets, pieces of cloth, or anything else. Sharp and projecting points of bone must be exsected. Nor do we hesitate to say that, in case the disease has made but little progress, especially if only the muscles of the jaw are involved in the spasms, amputation will often afford a reasonable ground for hope; particularly when the amputation does not involve parts near the body, as where the wounds are situated in the fingers or toes, or even in cases of injuries of the forearm or lower portions of the leg. We are informed that in a case of trismus presented in one of the U. S. hospitals at Washington, prompt amputation of the forearm completely arrested the disease. Many similar examples have from time to time been reported by surgeons.

When tetanus supervenes upon the closure of the wound,

and a nerve is supposed to be involved in the cicatrix, Larrey has recommended cauterization of the cicatrix, and free incisions upon the cicatrix, or section of the nerve at some point above. This latter operation may also, with propriety, be practised where the wound is still open.

In relation to the general treatment, great difference of opinion continues to exist. Among the remedies proposed and which have been actually employed are cathartics, especially calomel, castor-oil, and turpentine; colchicum; camphor, tobacco, with nearly all of the various anti-spasmodics and sedatives; cannabis Indica; alkalies; opium, in some of its forms; tonics; stimulants; chloroform and ether; nutritious diet; the application of the moxa, and of other counter-irritants to the spine. All of which agents have been said to effect cures; and at one time or another have been held in popular favor.

The use of woorari has been suggested, but we are not aware that it has ever been tried.

In our opinion, but few of these remedies are entitled to any special confidence; by far the largest mass of testimony having accumulated in favor of nutritious food, tonics, stimulants, and opiates; the latter of which, if employed at all, must be given in the most liberal and persevering manner; in some cases both by the mouth and by the rectum, or by the endermic method.

Chloroform has been tried very largely during the past few years, and so far as we can learn, almost universally by our army surgeons, but not with a success which in our judgment would warrant its continuance—or to say the least, its substitution for opium or morphine. We have been repeatedly informed by those who have made use of it, that it generally controls in some measure the spasms; but not always does it even accomplish this, while it

appears in most cases to cut short the disease by a more speedy termination in death.

It would seem, indeed, that whatever general remedy we employ, we cannot hope for recovery except by sustaining the system until the local irritation (which we assume to be the *immediate* cause of the spasms in a large proportion of cases) has been subdued. The effects of chloroform seem to be too transient to accomplish this end, while its general effects are too exhaustive to the vital forces to render its long continued use in full doses compatible with life. In short, it is likely in itself to kill the patient before the disease can be extinguished; or, we might say, before the nervous lesion—whether it be a local irritation or inflammation, or whether it be in consequence of a general blood-poisoning—has had time to cease.

We might occasionally resort to chloroform in moderate quantities for the purpose of controlling measurably those violent paroxysms which the opium had wholly failed to affect; and we would give it freely in all cases where death seemed inevitable, for the purpose of removing the pangs of dissolution; but with the evidence as it now stands before us, we could not resort to it as the most reliable means of saving life.

The subject of the treatment of this terrible affection is at this moment a matter of so much importance, and opinions are still so much at variance, we hope the Medical Bureau at Washington will, as soon as possible, give us the results of the experience of our surgeons during the present war.

CHAPTER XXV.

SCORBUTUS.

When treating of the diet of troops, we had frequent occasion to allude to the subject of scurvy, both in reference to its causes, symptoms, and treatment; and we took especial pains to call attention to the various forms of disease with which it was likely to be complicated, or more properly speaking, to the various phases which this malady was apt to assume.

Many of these points we shall not think it necessary to discuss again.

In relation to the pathology of scurvy, different opinions have from time to time been entertained; but at the present moment a general belief prevails that it is due essentially to the absence of certain staminal principles from the blood, and especially potash. This opinion accords with our own convictions. Dr. Budd was the first, we believe, to suggest that fruits and vegetables act as anti-scorbutics by furnishing to the system certain organic salts which are essential to nutrition. Dr. Garrod, following in his investigations these suggestions of Dr. Budd, affirmed that potash is the base of the salt thus supplied. It appears to be pretty well ascertained that all, or nearly all, of those remedies which have been employed successfully in the prevention or cure of scurvy, contain potash. Potatoes, cabbage, celery, lettuce, lime, lemon and orange juice, contain it in large quantity, unless their salts have been expressed by

the application of heat, as in boiling or other modes of cooking. Lime, lemon, and orange juice contain nearly one grain of potash to every ounce of the juice. One ounce of potatoes yields one grain and a half; while one ounce of rice yields only .005 of a grain. The substitution of rice for an equal amount by weight of potatoes in an English workhouse was followed in a short time by scurvy. Many similar observations and experiments seem to have established the fact that the entire absence of potash in the articles consumed as food, will eventually give rise to scurvy. Among the conclusive experiments upon this subject, we desire to refer especially to those made by Wm. Hammond, late Surgeon-General, U.S.A. It is proper, however, to state that Dr. Hammond considers scurvy not due solely to the absence of potash, but to this circumstance in connexion with other morbid alterations in the blood.*

But whatever theory of causation we may adopt, there is perhaps no malady in which the principles of successful treatment are better understood, or more thoroughly established.

The most essential point in the management of scurvy is the free use of those articles of diet by whose absence it is known to be caused; and these are fresh vegetables and fruits of nearly all kinds. Of the vegetables, potatoes have long been understood to be the most efficacious, and especially when they are eaten raw. It is equally true of all other vegetables and of the fruits, that their anti-scorbutic properties are measurably lost by cooking. Our sailors frequently cut the potatoes into slices and pack them in a barrel with molasses, in order to their preservation. It is their opinion, also, that the molasses renders them

* Paper on Scurvy, communicated to the U. S. Sanitary Commission.

more effective, but this opinion is not sustained by careful experiment. When eaten, they are usually scraped fine with a grater or a knife, and mixed with a little vinegar.

Onions are scarcely less useful than potatoes, but being much more perishable, they cannot be of equal value as army supplies. They may be preserved, however, without much loss of their anti-scorbutic properties, by cutting them into slices if they are large, and pickling them in vinegar; if small, they may be pickled without cutting.

Cabbage, either raw or prepared as sour-krout; celery, sorrel, lettuce, turnips, are known to be anti-scorbutic.

Desiccated vegetables, to which particular reference has already been made in a previous chapter, possess no inconsiderable virtue as a preventive, if not as a cure of scurvy. They are very inferior, however, to the vegetables in a fresh state.

Assistant-Surgeon Ridgely, U.S.A., reported in 1856, from the cantonment of the Sixth Infantry, Nebraska Territory, the appearance of scurvy among the troops, which was promptly arrested by the bulb of the wild artichoke, of which the men ate freely; and Surgeon Madison, stationed at Fort Randall, Mo., speaks also of the wild artichoke as "a most excellent anti-scorbutic." It was found to be edible from the first of April to the middle of May. The same surgeon speaks favorably of the wild onion and the wild nettles. He adds, moreover, "The Indians eat nothing save fresh game or dried buffalo meat, and they put up for winter quantities of dried plums, buffalo berries, choke berries, etc.; hence their immunity."

In a paper published in the *New York Jour. of Med.*, September, 1851, G. Perin, then Assistant-Surgeon United States Army, late Medical Director, Army of the Cumberland, writing from Fort McIntosh, Laredo, Texas, first

introduced to the notice of the profession the Agave americana, or Maguey, a species of cactus, as an anti-scorbutic. It is the same plant from which the drink called "pulque" is manufactured, and is indigenous to Texas, California, and Mexico. As a remedy for scurvy, Dr. Perin places it far above lime-juice, or any other remedy known to him. Surgeons Johns, Meyer (chief of the U. S. Signal Corps), and many others, confirm these statements. It is prepared as follows: the leaves being cut off close to the root, are placed in hot ashes until thoroughly cooked, when they are removed, and the juice expressed from them and strained. It may be given in doses of from two to three ounces three times daily. The internal or white portion of the stalk of the plant is also a wholesome and nutritious food.

Surgeon Swift, U.S.A., has informed the writer also, that he has employed for the same purpose, when residing in Texas, the leaves of the Cactus apuntia, or prickly pear, a plant which we have found growing wild in most of the Southern and Middle States, and some of the North-Western States; and he regards it as not at all inferior to the Agave americana. It may be prepared for use by filtering the fleshy leaves, under pressure; and of the juice thus obtained one ounce may be given several times daily. We have prepared them as a salad, by first roasting the leaves in hot ashes and then peeling off the outer skin, which is covered with small spines, and cannot be handled safely without buckskin or kid gloves. We confess, however, that it did not prove very palatable, although some medical gentlemen who gave it a trial professed to relish it. Prepared in this way, being very soft and mucilaginous, it makes an excellent poultice.

The French, in the Crimea, derived the greatest advantage from the use of the leaves of the Leontodon taraxacum,

or dandelion, which plant grows everywhere abundantly in the United States.

According to our experience, green corn possesses no little anti-scorbutic virtue; and we desire again to call attention to what we have before said upon the subject of corn as a diet for troops, and especially to the observations of Dr. Southworth, U.S.V., originally published in the New York Med. Times, Aug. 8, 1863. Green apples, cherries, and in short nearly all kinds of fruit, whether green or ripe, will frequently very materially modify, if they do not wholly eradicate, the scorbutic taint. Oranges and lemons have long been known to rank among the most potent remedies of this class. Prof. McCready remarks: "The effect of lemon-juice in preventing the attack of scurvy was early observed. In the voyage under Commodore Lancaster to the East Indies, in 1760, of four vessels, three suffered from scurvy to such an extent as to lose one-fourth of their crews, and to disable the remainder. On the fourth vessel, commanded by the Commodore himself, every morning three table-spoonfuls of fresh lemon-juice were served out to each of the men, and none of them suffered from scurvy. Yet this fact was entirely lost sight of, and the disease continued to decimate the navy, until, in 1795, through the exertions of Dr. Lind and Sir Gilbert Blane, the general use of lemon-juice was introduced among seamen.* In this year lime-juice was made a part of the navy ration by an Admiralty order, "and from this period may be dated the final expulsion of scurvy from that service, and the sudden diminution of the sickness and mortality to an extent scarcely credible."† On board Her

* Practical Treatise on Military Surgery, by Frank H. Hamilton, including a chapter on Scorbutus, by Prof. Benjamin W. McCready, p. 205, 1861.

† R. S. Farquharson, passed Assistant-Surgeon U.S. Navy, on Scurvy in the U.S. Navy, New York Med. Times, 1863, pp. 35, 61, *et seq.*

British Majesty's ships one ounce of lime-juice is served out to each man daily, beginning two weeks after the issue of the last fresh ration, and the amount may at any time be increased at the discretion of the surgeon. It is employed, therefore, as a prophylactic rather than as a remedy.

In the American navy, lime-juice has been supplied for many years as one item of the hospital stores, but not as a ration, nor in sufficient quantities to be used as a prophylactic. The consequence has been that our navy has not hitherto possessed the same immunity against scurvy as the British. During the Mexican war two of our vessels were, in consequence, nearly or quite disabled; and the malady has frequently been found on board of our vessels employed in long cruises.

Fresh, as a substitute for salt meat, has also an important influence upon the prevention and cure of scurvy. Those who regard the absence of potash in the dietary as the cause of scurvy, offer as an explanation the fact that when fresh meat is covered with dry salt, the salt rapidly becomes moist, attracting the juices from the meat, and thus condensing and hardening it. These juices contain various salts held in solution, of which salts potash constitutes a considerable proportion. It is supposed, therefore, that it is by the abstraction of this staminal principle that the salt renders the use of meats thus preserved prejudicial to health.

Finally, among the remedies which have been proposed are the various salts of potash themselves. Dr. Hammond affirms that "not only was the use of water containing potash found to procure an exemption from the disease when its causes were peculiarly rife, but in the treatment of cases one salt of potash was successfully substituted for another."

During the Peninsular campaign, when the troops were beginning to suffer from scurvy in consequence of a lack of fresh vegetables, we requested several surgeons of the Sixth Corps to resort to the bitartrate of potash, in doses of from two to four drachms daily; and they subsequently reported to us that the remedy had in every case proved effectual.

Benjamin F. Bache, Surgeon U. S. Navy, and Director of the Naval Laboratory, Brooklyn, N. Y., informs us that he has used with excellent effect Turner's old remedy, namely—

Potassæ Nitratis ʒ ij.
Acidi Acetici f. ʒ viij.
M. ft. Sol.
Dose: f. ʒ ss. ter in die.

To these remedies may be added, as having anti-scorbutic properties, wine, cider, spruce-beer, and vinegar made from apples. Vinegar made by the German process, in the acetous fermentation of alcohol, is worthless. It is therefore a matter of regret that our armies have of late been supplied so exclusively with the latter article, possessing, as it does, no claim for consideration except in its relative cheapness.

Iron has been recommended, and Dr. Hammond has found it highly serviceable, especially when given in the form of the tincture of the chloride, in doses of thirty drops three times daily.

Air, light, exercise, cleanliness, and certain moral agencies have the same beneficial influences in this disease as in all other maladies of a chronic character, when the general tone of the system is depressed.

CHAPTER XXVI.

ON THE EMPLOYMENT OF ANÆSTHETICS IN MAJOR AMPUTATIONS AND IN OTHER SEVERE SURGICAL OPERATIONS, AFTER GUNSHOT INJURIES.

McLeod maintains that anæsthetics do not generally increase the shock, or the nervous depression consequent upon severe injuries. He has reaffirmed his confidence in these agents, and especially in chloroform, by the following unequivocal language: "If we believe, as I certainly do, that by the use of this anæsthetic, all fear of intensifying the shock is obviated," etc.; and Baudens assures us that "they had no fatal accidents to deplore from its use, although during the Eastern campaign chloroform was employed thirty thousand times or more."

Such testimony demands respectful attention, and cannot be rejected except upon the most satisfactory evidence of its fallacy or unsoundness; but there are points in the testimony which need explanation, and certain facts of experience which will in some degree weaken its authority.

M. Baudens has no doubt said honestly that so far as he has been informed or has himself seen, no fatal cases have occurred from the use of chloroform in the Crimea; and yet, judging from the number of deaths from this cause already reported in civil practice, it is fair to assume that some fatal cases have occurred also in the Crimea. What means of information does M. Baudens possess, which can be considered reliable, as to the number of deaths which it

may have occasioned in the trenches, where it was constantly given by inexperienced assistants, and who might not always be able to distinguish between the effects of the injury and of the chloroform?

Admitting, however, that in no case did death result immediately from its use, there is another question to be determined to which these writers do not allude, and which we think has heretofore been kept too much out of sight by those who have spoken upon the subject of anæsthesia in general—we refer to the question whether its after-effects upon the system and upon the wounds are favorable or unfavorable.

Says McLeod: "I never saw one case among our most numerous amputations in which primary adhesions took place throughout the whole surface of the flaps." Is not this a most unparalleled experience? Do the annals of surgery furnish another such example? Why did these wounds so uniformly refuse to unite by first intention? It is in vain to invoke by way of explanation, bad diet, fatigue, exposure, discontent, cold, heat, moisture, ill-ventilated hospitals, or crowded transports; these were all, at one time or another, active agents in the production of disease in the Crimea, but none of them were constantly present; and especially during the last year of the campaign —thanks to the intelligence of the English medical officers, and to the energy of the British nation—were nearly all of these depressing influences absent. "Every man was then in health and vigor—literally full of lusty life—and actually rejoicing in his strength."

We submit, therefore, whether it is not proper to look for some other more constant cause for such remarkable results, than any or all of those which have been enumerated—a cause which might be found acting, perhaps, solely upon

the wounded soldiers. Before these injuries were received they were all "full of lusty life," but, immediately that a surgical operation was made, the functions of life were so much lowered that the natural processes of repair were uniformly interrupted or completely arrested.

In the second Grand Division of the British army chloroform was not used, owing to an "aversion to it entertained by the principal medical officer of the division, a gentleman of extensive experience;" and Guthrie has called attention to one example of double amputation made in that Division, at the shoulder-joint, and through the thigh, without chloroform, and in which primary union occurred in the thigh, and the shoulder healed kindly by granulation.

Mr. Guthrie also quotes one case of immediate death from chloroform in the Crimea, in which the anæsthetic was given for the purpose of amputating a finger.

These examples are of no importance in themselves, except as they show that the statements made by McLeod and Baudens are not to be taken without some allowance. These cases had not come to their notice, and perhaps the same may be true of many other cases.

It is very natural, while contemplating the virtues of one of the most valuable discoveries ever made in medicine, that we should overlook and be reluctant to admit its defects. The danger is indeed very great that we shall do so; and in the name of humanity, we demand for this question a most careful consideration.

We have many times had occasion to notice the appearance presented by the stump immediately after an amputation made upon a patient completely narcotised by chloroform. The muscles hang out very much as they do in operations made upon the cadaver; they never quiver nor

retract; nor, in some cases, is the retraction of the muscles completely accomplished until after several hours or even days. Can this condition of the wound be favorable to early union of the surfaces? It bleeds freely under these circumstances, but it is seldom we shall find any lymph deposited upon the surface, even when it has been allowed to remain open an hour or more. We have noticed, also, the prostrated condition of the patient, consequent plainly upon the action of the anæsthetic, and continuing several hours or days, accompanied with loss of appetite, and not unfrequently with persistent nausea and vomiting; the pulse being feeble, rapid, the surface of the body pale, and the mind irritable; and we think we are not mistaken in supposing that of late, since the introduction of anæsthetics, we have seen fewer examples of union by first intention, in civil practice, and more of suppuration, with also purulent infection, or pyæmia. In military practice, as observed by us in the American field and hospital service, union by first intention after amputation is one of the most rare events; so that many, perhaps most, of our surgeons are again returning to the old practice of leaving these wounds open; experience having shown that primary union is not to be expected.

Dr. Valentine Mott, in a very interesting paper on anæsthetics, communicated to the U. S. Sanitary, and published by that Association, gives them his almost unqualified approval in all capital operations. He prefers chloroform to ether. We must, however, take the liberty of making a single criticism upon one point in his paper. Before anæsthetics were introduced Dr. Mott was in the habit of giving opiates freely, both before and after operations; but of stimulants he observes, they sometimes occasion nausea, and "the act of retching tends to an unfortunate issue. * *

In collapse, if the patient vomit he is apt to die." How much more prone the anæsthetics, both ether and chloroform, are to induce nausea than any of the ordinary stimulants, is notorious. Is the nausea induced by these agents any less mischievous than that induced by brandy? Perhaps it is; but we do not think so. In our experience, their effects in this respect have been as persistent and troublesome as the effects of brandy or even opium. In many cases which have come under our observation, the nausea and vomiting have continued for many days, and we can see no reason to suppose that the consequent prostration and loss of appetite were any less detrimental.

The following remarks on the employment of anæsthetics in military surgery, are from the pen of Dr. Z. Pitcher, Surgeon in the United States Army, during the war of 1812, and at present the surgeon to St. Mary's Hospital, Detroit; they constitute a portion of a private communication made to the author a few years since:

"You will observe that, in what I have said on this subject, I have spoken only in such general terms as will serve to convey my idea of the principle by which my own conduct has been governed, and by which I would direct the action of others, and that I have not affected the precision of a clinical instructor. Such cases as I can most distinctly recall, illustrative of what I have already said, I propose to speak of in connexion with the use of anæsthetics in cases of shock, the effects of which I think it my duty to place on record, they being the results of my own experience in its administration, where the subject was approaching the state of collapse.

"Whenever there is sufficient force in the circulation, and nervous activity enough to sustain the patient, I would give my voice with the general judgment of the medical

profession, by which the use of anæsthetics in the severer operations of surgery is sustained. But regarding them as poisons of a sedative class, which, when introduced in the blood, produce cerebral exhaustion and cardiac syncope, if they do not change the physical and vital properties of the blood itself, I feel obliged, in discharging a duty incident to a compliance with your request, to remonstrate against their use in cases of syncope, or nervous exhaustion.

"Two men were conveyed to the hospital under circumstances so nearly identical, that I could scarcely say wherein they differed, unless in temperament, each having had a leg carried away so near the knee that amputation was performed above the joint. They were nearly of the same age, they had good constitutions, and neither of them was intemperate. One was put under the influence of chloroform, and the other not. Neither made favorable progress, but the one subjected to the influence of the anæsthetic came out of that condition with increased prostration, and never regained what he had thus lost. The other rallied slowly, and union of the wound took place very late. The increased prostration in the first case may be explained on either of two hypotheses; but the latter example, strengthened by others, inclines me to impute the increased prostration to the anæsthetic, rather than to the operation."

Dr. J. B. Porter, Surgeon U. S. Army, in a communication to the *Amer. Jour. Med. Sci.*, 1852, states, that after a fair trial at the General Hospital, Vera Cruz, in 1847, anæsthetics were entirely given up; and he adds—

"It may be well questioned whether anæsthetics are not calculated to produce injurious effects in all important amputations; but they certainly do so in operations performed for gunshot wounds. M. Velpeau says: 'Chloroform evidently depresses the nervous system, and, as great

prostration always exists in patients who have received gunshot wounds, it is advisable to refrain from any anæsthetic means.' Mr. Alcock refers to the cases of soldiers wounded in battle, where the excitement is such as to carry them through almost any operation. I regret that Mr. Alcock's paper is not before me. These are the cases spoken of by Mr. Guthrie: 'Soldiers in general are anxious to undergo an operation when they find it inevitable, and frequently press it before the proper time; that is, before they have sufficiently recovered the shock of the injury.' These are the cases which require a little more time, some 'encouraging words,' and perhaps a little wine, or brandy and water; but no anæsthetics, for the patients are already sufficiently depressed.

"There are two sets of cases; in one (Velpeau's), the shock to the nervous system is great, from which the patient may not recover, and the use of anæsthetics would be awfully destructive; in the other class, they are unnecessary, and would prove useless and injurious. In the flap operation they must prove more injurious than in the circular; from the fact that muscle forms almost the entire covering for the stump; and the contractility of the muscular tissue is for a time almost annihilated, to be recovered irregularly at irregular intervals. Further, after the use of these agents, wounds do not heal so readily by the first intention. * * * * * * * *

"In an unhealthy atmosphere or climate, the healing of wounds by adhesive union is doubly important, for obvious reasons; and I have often regretted that etherization was so much resorted to in capital operations at Vera Cruz during a portion of 1847; nor can I avoid congratulating both the patients and myself, that, before the summer had passed away, its employment was wholly abandoned.

Anæsthetics poison the blood and depress the nervous system; and, in consequence, hæmorrhage is much more apt to occur, and union by adhesion is prevented."

M. Jobert, on the use of ether, states that the local inflammation has proved less, and that union by the first intention has been prevented.

In the New York City Hospital the reports from January 1, 1848, to April 1, 1851, made by Dr. Lente, the resident surgeon, present one case of amputation at the hip-joint resulting in death; 17 of the thigh, of whom 13 died; 2 at the knee-joint, both died. Of 40 amputations of the lower extremities, including both leg and thigh, 22 were fatal. "In almost every case chloroform or ether were employed." In the only case in which it is distinctly stated that no anæsthetic was administered, the patient recovered. This patient being much prostrated before the operation, stimulants were substituted for the anæsthetic. Of 24 primary amputations of the lower extremities, 16 died, or 66.66 per cent.*

Dr. Lente proceeds to show that the mortality, according to Dr. Buel's reports, from January 1, 1839, to January 1, 1848, was 28.57 per cent., while the mortality in the three years and three months succeeding was 39.68 per cent. Dr. Lente is disposed to think that these unfavorable results during the last-named period may be merely accidental, which is indeed possible; but he offers a farther explanation, which is, to say the least, to us quite as satisfactory:

"Anæsthetics came into general use about the period of the commencement of these statistics" (January 1, 1848). "May not the employment of these have had its influence upon the mortality? This is a very important question. We do not deny that it may have had some influence in

* Transactions Amer. Med. Assoc., vol. iv., pp. 271, 340, A.D. 1851.

augmenting the fatality of operations; but we have seen no reason to infer that it has, except perhaps the fact that union by adhesion seems to have been much less frequent since the introduction of anæsthetics into this hospital than before. Whether the two are in the relation of cause and effect, it is, we fear, impossible to determine at present."

Dr. Lente further suggests as a probable cause of the increased mortality the sudden accession of hospital gangrene in the surgical wards during the year 1849, which had never appeared in that hospital before; and the unusual prevalence of purulent cachexia and of erysipelas.

We think the inference is equally logical that some novel plan of treatment, introduced first in the beginning of this unfortunate period, by increasing the suppuration of wounds, caused also the "purulent cachexia," the "erysipelas," and the "hospital gangrene;" and we submit whether there is not a fair ground for suspicion that the anæsthetics were these mischievous agents.

Since the reports made by Dr. Lente, we believe no statistics of amputations have been published from that institution.

Dr. Charles Wallace Clay, who has operated for the removal of ovarian tumors one hundred and four times, and whose judgment as an operator no one will question, observes, that if a patient can make up her mind to submit to so formidable an operation, he thinks her chance would be better without the chloroform or ether. In his opinion, the vomiting which so commonly follows this operation is due to the anæsthetic.*

Mr. Coulson, of London, who prefers chloroform, thinks there are many cases in which sensation ought not to be completely annihilated during an operation, for the reason

* Boston Med. and Surg. Jour., Oct. 1863, p. 176.

that the patient's sensations are often the chief guides which direct the surgeon when he is going wrong, as in cases of lithotrity, and in certain obstetrical operations. He also places other restrictions upon its use, but as they are not pertinent to amputations, we do not care to notice them in this place; but he adds: "In addition to local circumstances, there may be certain general conditions of the patient which would render the use of chloroform doubtful. Thus it has been a question how far the agent can be safely employed in cases where a severe shock has been already produced by violent and extensive gunshot injuries."*

Mr. Cole, an English surgeon, regards chloroform "as a highly pernicious agent," and desires that it should be entirely excluded from field, and field hospital practice.

We are informed by the editor of the American Medical Times, that another English surgeon in the Crimean war says, although he has never made any capital operation without chloroform, yet at the same time he must in candor confess that he does not altogether like it, and that there are cases in which the value of its assistance may be questioned. The writer proceeds to explain the cases to which he has especial reference, as cases of shock, and of exhaustion; in which cases he declares he should dread the effects of chloroform. * * * "I have seen," he adds, "more than one instance where the patient has lain on the table, after an operation, performed too under the most favorable auspices, so reduced by the effects of chloroform as to cause considerable anxiety to the operator." Speaking of those cases of which we often hear "that the operation was skilfully performed, very little blood lost, but the patient never rallied, and died in a few hours," he says: "My own impression, from what I have seen of the effect of the drug, is,

* Lancet, Oct. 20, 1855.

that many of these cases died from the exhaustion induced by the shock of the injury, and the consequent operation; but that this exhaustion was assisted and kept up in a most material degree by the depressing influence of chloroform."

On the whole, it seems to us that neither Guthrie, McLeod, Longmore, nor any of the leading English writers on military surgery have given us a fair exposition of the views of English military surgeons, or indeed of English civil surgeons, upon this subject; a large minority of whom have witnessed, and have frankly declared the evil effects of anæsthetics, especially in certain cases of traumatic accidents.

We shall be able to understand the views of British surgeons better by the following summary of their opinions, drawn from the Crimean army reports, and given to the public by the Director-General of the Medical Department of the British army. It must be remembered in explanation of the fact that no opinions are given, except in relation to the effects of chloroform, that only chloroform was used. The reader must judge for himself how far these opinions will apply to ether, or any other anæsthetic.

1. "The majority believe the use of this anæsthetic desirable in all cases, both of slight and severe wounds, requiring operations, where no organic disease exists (a circumstance little likely to be the case in a soldier on active service), due precautions being taken in its administration.

2. "A few practically concur in this view; but object to its use in minor operations, on the ground of its occasionally producing bad results, even when of good quality and properly administered.

3. "A large minority object to its use in cases of very severe shock, more especially when much blood has been lost; on the ground that these cases frequently do not

rally; and this they in a great measure attribute to the depressing effect of the drug, after the anæsthesia has gone off; and this independent even of the depressing effects of vomiting, which is not an uncommon sequence of the administration of chloroform in such cases.

4. "A smaller minority believe its use to be dangerous in secondary operations, when the patient's system has been very much reduced by large purulent discharges, and more especially when this reduction has taken place with rapidity greater than usual, from inordinate amount of discharge, or from the addition of secondary hæmorrhage.

5. "That the first effect of the drug is probably stimulant is not denied; but this is believed to be speedily followed by depression, and this depression is thought to take place usually, or almost always, even before the anæsthetic effect passes off—and it is thought the vomiting (or attempts at vomiting) not unusually following its exhibition, is an evidence of this, and, perhaps, materially aids in producing the danger."

Gross, of Philadelphia, who finds very few cases in which chloroform may not be employed with safety and propriety, has nevertheless given this qualified testimony as to its possibly injurious effects: "An advantage which has often been claimed for anæsthetics is, that there is apt to be less hæmorrhage during operations; I am, however, in doubt whether this is true, and, even if it were, any good that might thus accrue would be more than counterbalanced by the liability to secondary bleeding, caused apparently by a partial loss of tone in the smaller vessels, interfering with the formation of protective clots. Possibly the blood itself may be more or less at fault."

The statistics of the Massachusetts General Hospital can scarcely be said to furnish any evidence of the injurious

effects of anæsthetics in amputations. Up to the year 1850 —four years after the introduction of anæsthetics—the average mortality of all amputations was 22 per cent.; but the mortality in twenty-eight cases where anæsthetics were employed, was 25 per cent. To Dr. Shaw, the Resident Physician and Superintendent, we are indebted for the results of amputations in that institution from the year 1850 to 1860. Ether has been used exclusively; and notwithstanding the "greater severity of cases (mostly railroad and street accidents), and the more crowded condition of the hospital," the average mortality is substantially the same as before the introduction of ether; the deaths in a total of two hundred and seven amputations amounting to 22.7 per cent. The number of deaths after eighty-six amputations of the thigh has been nineteen, or 22.1 per cent.; and after eighty-four amputations of the leg twenty-four, or 28.6 per cent.

To our mind this testimony demonstrates the superior safety of ether as compared with chloroform; and affords presumptive evidence of care and judgment on the part of the surgeons in that hospital in the administration of this comparatively, but not absolutely, innocuous agent.

Finally, after having made this brief summary of the opinions of both foreign and American surgeons, so far as they are known to us, and after a careful examination of our own experience, we will state our belief and conclusions as follows:—

Anæsthetics are of inestimable value in their effects as remedial agents; in their power to extinguish sensibility temporarily, especially during the performance of certain painful surgical operations; in the control which they exercise over muscular action, thus facilitating the reduction of dislocations; and in very many other ways.

Anæsthetics, however, produce certain effects upon the system which tend to prevent union by first intention; and consequently they must be regarded as, indirectly, causes of suppuration, pyæmia, secondary hæmorrhage, erysipelas, and hospital gangrene.

Ether ought generally to be preferred to chloroform, as being less liable to destroy life immediately; but no anæsthetic ought to be employed when the system is greatly prostrated by disease, or by the shock of a recent injury, or by loss of blood, unless the patient exhibits an unconquerable dread of the operation, or the operation is likely to prove exceedingly painful.

It ought to be particularly borne in mind that by the loss of a large amount of blood, the action of absorption is greatly increased, and that, consequently, such patients come more rapidly under the influence of the anæsthetic.

The above conclusions have been well considered, and are carefully stated; and we respectfully ask that surgeons will at least attach to our opinions sufficient importance to induce them to continue their clinical observations upon this subject. We desire especially that surgeons in charge of hospitals will publish their statistics of thigh amputations, and carefully indicate in their reports the period of the amputation and the condition of the patient at the time.

Our own experience extends over a period ante-dating the introduction of anæsthetics by twelve or thirteen years, and in all this time we have been a constant observer of hospital practice; and we are compelled to say that our success in capital operations, especially in primary thigh amputations, has not been as good since we began to use these agents as it was before. We have generally employed ether, and with the exception of the amputations made at

the first battle of Bull Run, we have made no capital operations without employing some anæsthetic. On that occasion we had no anæsthetics; but the wounded having been left in the hands of the enemy, the results cannot be stated. The apparent inconsistency between our own theory and practice is explained by the fact that surgeons generally reäffirm the sentiments of Mr. Skey, and declare that these drugs are "innocuous agents of good," consequently patients will no longer submit to operations without them.

In the exhibition of these agents we observe that infants receive them with greater impunity than adults; and persons of a phlegmatic temperament come more easily under their influence than persons of a sanguine or nervous temperament.

No patient ought ever to take an anæsthetic in the sitting posture. A large proportion of the fatal cases have occurred in the hands of the dentists, when the patients were sitting, or only partially reclining. The safest position is reclining upon one side; when the patient lies upon his back he is in some danger of suffocation from the falling of the tongue and epiglottis, and the accumulation of fluids in the mouth.

When ether is administered a towel should be folded into the form of a cone, the base of which should be large enough to inclose the whole face; this should be covered with a newspaper, to prevent evaporation; a large sponge should be thrust to the bottom of the cone and saturated with ether.

The base of the cone being laid over the face, the patient should be instructed to make a full inspiration; and as soon as this is done the cone should be removed, so that he shall not be required to inspire again the air which he has

just expired; when the patient repeats the inspiration the cone should be replaced upon his face, and again withdrawn on expiration.

By this method the subject may be brought rapidly under the influence of the ether, and he is in no danger of being suffocated. It is painful to see how some surgeons hold down and strangle their patients in their rude attempts to administer anæsthetics. The battle for air which the poor sufferers make increases their exhaustion, while the spasmodic closure of the glottis prevents the anæsthetic from being received into the lungs, if it does not actually endanger suffocation. No surgeon, it is believed, would ever permit the same to be done to himself, whatever might have been his own previous views of the value of this practice.

While the anæsthetic is being given the pulse should be held by the surgeon, and the respiration and countenance carefully observed. The patient should be occasionally spoken to, and when he ceases to respond, the operation should commence at once. It is neither necessary nor proper, in our opinion, to wait until, on lifting an arm or a leg, it falls with a dead weight upon the table; and the anæsthetic should be discontinued some time before the operation is completed. In short, the inhalation of the anæsthetic ought not in any case to be prolonged one moment unnecessarily.

If respiration or pulsation ceases, the patient should be rolled over from his side to his face, or from his face to his side, and these motions should be repeated several times, pressing meanwhile upon the chest to imitate respiration. The chest may be forcibly struck with the palm of the hand, or cold water dashed upon it.

We have seen no benefit from stimulants or opiates

given internally, either before or after administering anæsthetics. They seem only to increase the tendency to nausea and vomiting. If possible, the stomach ought to be entirely empty when these agents are given, and it should remain so for some time after.

The patient being removed to his bed, should be allowed to sleep, with an abundance of fresh air circulating about his face. When he awakes and consciousness is fully restored, he may be allowed a small cup of hot coffee or of tea, provided, of course, there is no nausea. If he is inclined to retch, small pieces of ice will be preferable.

There is usually considerable nervous excitement, manifested especially in a disposition to talk, during the twenty-four or forty-eight hours following the inhalation of the ether. Strangers should not be admitted to the bedside, and the friends must enjoin quiet and silence; indeed, the patient seldom sleeps much after he is once fairly wakened, for many hours; but all drugs exhibited for the purpose of inducing sleep during this period tend to induce nausea and to increase the prostration, and had better be withheld.

The opinions which we have expressed in this chapter were given publicly at a recent session of the New York Academy of Medicine, and we deem it our duty to state that they were substantially accepted and reäffirmed by Drs. Buck, Post, Miner, Jos. M. Smith, and others of the distinguished medical gentlemen who took part in the discussion; but that they did not accord with the views or observations of Drs. Detmold, Krackowizer, or Peaslee. These latter gentlemen, for whose opinions we, in common with the profession generally, entertain the highest regard, had not observed after the employment of anæsthetics any

failure in the reparative process which could fairly be attributed to these agents.

Since it is our desire only to arrive at just conclusions in a matter which concerns us all alike, we shall hold our opinions subject to revisal, and submit cheerfully to the final verdict of experience.

APPENDIX.

AMPUTATION AT HIP-JOINT FOR GUNSHOT INJURIES.

THE following is the example of amputation at the hip-joint, made by Dr. Carnochan, for a gunshot injury of the thigh, to which reference has been made at page 485 of this volume. I shall take the liberty of reporting it in his own words:—

"NEW YORK, 14 EAST SIXTEENTH STREET,
"November 7th, 1864.

"DEAR DOCTOR,—In answer to your note of this morning, I would state, that the operation you speak of was performed on the 18th of May last, during the battle at Spottsylvania. I was at the Hospital Head-Quarters of the Ninth Corps, under the management of Medical-Director O'Connel. The wounded were pouring in directly from the field, the battle raging fiercely a few hundred yards off. By invitation of Dr. O'Connel, I had taken part in the operations of the morning, from about five A.M. until nine o'clock, when becoming fatigued I went out into the hospital yard. While there, I observed a soldier, who had recently been brought from the field, lying upon a stretcher, and apparently abandoned amongst the mass of mortally wounded and those who had been operated on. I spoke to him, and found him quite collected and in full possession of his senses. He had received a shell wound which had shattered his left thigh completely, leaving the lower part of the limb attached to the upper by a few shreds of integument and muscle. He had been wounded about three-quarters of an hour before, and, as yet, had not had a tourniquet applied. The pulse was perceptible, and although

in extreme collapse, he had received no other injury to complicate the case. The wound left the tissues above perfectly sound, and suitable for an amputation at the hip-joint.

"I called the attention of Dr. O'Connel and some of his staff to this patient and to his general condition. It was thought best to give him the chance of an operation, rather than allow him to die without an effort to save him, and I was selected to perform it.

"The patient was brought into the operating room, and chloroform carefully administered by Dr. Harris. It was desirable that as little blood should be lost as possible, and as a preliminary step, I secured by ligature the common crural artery, three-quarters of an inch below Poupart's ligament. I chose the oval or oblique method of operating, somewhat after the manner of Guthrie. A longitudinal incision, commencing about an inch above the great trochanter, and extending downwards over the centre of that process for about three inches, was first made, dividing the soft parts down to the bone. From the lower third of this incision, two oblique incisions, one before and one behind, were made to diverge, so as to form the superior part of the oval. The head of the femur was then disarticulated, and the knife passed around it to the inner side of the neck of the femur; it was then carried downwards, close to the bone, as far as the termination of the two oblique incisions. The operation was finished by dividing, at one sweep of the instrument, the muscles and skin, outwards and downwards, two and a half inches below the level of the ischiatic tuberosity. The whole operation was over, including the ligature of the femoral, in about two minutes. The patient came out of the anæsthetic influence kindly. He was removed to a shelter-tent, in the hospital yard, and some opium ordered. Amid the bustle and numerous duties of the day, this patient could not receive the continuous care and attention which his condition required. Could he have been plied with stimuli and cordials, judi-

ciously, there was no special reason why reaction should not have taken place. There was no opportunity under the circumstances to do this. I do not think he lost much blood before I saw him, and his age and condition were in his favor. as he was not more than twenty-eight years of age, stoutly built, and apparently healthy. He was made more comfortable by the operation, the shattered and lacerated surfaces being converted into a clean cut. He died in ten hours after the operation, without reaction having taken place.

"I have performed this operation three times before in civil practice, the patients living from two to three days.

"Hoping that I have not trespassed too long upon your time in giving you such a detailed account,

"I remain, dear Doctor,

"Very sincerely yours,

"J. M. CARNOCHAN.

"Professor HAMILTON."

The following additional example has been kindly furnished us by Dr. A. B. Mott, which, with the two already mentioned, makes the third successful amputation which has come to our knowledge during the present war. It will be observed, however, that Dr. Mott's case differs from the other two in being both a secondary and a re-amputation:

"U. S. ARMY GENERAL HOSPITAL (Lexington Av., cor. 51st st.),
"NEW YORK, November 1, 1864.

"DEAR DOCTOR,—I send you the following brief statement of the case of Lewis Francis, Private Co. I, 14th N. Y. S. M.

"This man was wounded at the first battle of Bull Run, July 21, 1861. The rebels made a bayonet charge on his regiment, he receiving a penetrating wound of the right knee-joint. After falling, two rebels attacked him and inflicted fourteen bayonet flesh wounds, none entering large cavities. The left testis was so much injured by a stab that it was removed three days after.

"He was taken prisoner and removed to Richmond, Va. A Confederate surgeon amputated his thigh above the knee in October, 1861, for gangrene and an extensive abscess in lower part of the thigh. He received very bad fare, and slept on the floor until removed to Fortress Monroe in November, 1861, and while there four inches of bone were removed. Has been in hospital in Baltimore and Washington, and while at home, in Brooklyn, several large pieces of bone were removed.

"Admitted to this hospital October 18, 1863, suffering from extensive abscesses about the stump; stump painful and enlarged; discharge profuse, and general health much impaired. Under generous diet and stimulants his health was restored, but the bone being found diseased close up to the head, re-amputation was performed May 21, 1864, by myself; the patient being under the influence of an anæsthetic. The bone was disarticulated at the hip-joint. Numerous sinuses were laid open, all of which were subsequently filled in with lint.

"At the present date he is able to be out on crutches; wound not yet entirely healed, but doing well. Health much improved. The bone was extensively diseased up to the head; this, however, was not yet invaded.

"This statement is very brief. Please use what you can of it. Yours very sincerely,

"ALEX. B. MOTT,
"*Surgeon U. S. V.*"

Case of Gunshot Wound of Belly; the Ball entering at the Umbilicus and escaping per Rectum on the thirty-fourth day. Communicated to the author by D. R. BROWER, Assist. Surg. U. S. V.; from the U. S. General Hospital at Fortress Monroe, under charge of ELI MCCLELLAN, Assist. Surg. U. S. A.; October 27th, 1864.

R. S. L., 117th N. Y. V., wounded May 16, 1864, at Drury's Bluff, near Richmond; conical rifle ball entering

the belly at the umbilicus. On the twelfth day, May 28th, admitted to hospital at Fortress Monroe, with an umbilical hernia in a gangrenous condition. (The report does not state whether it was omental or intestinal.)

June 19th, the patient having had no movement of the bowels in ten days, a cathartic injection was administered, and this resulted in the passage of the ball by the rectum. The conical extremity of the ball was "much marked from contact with some hard body." Ten days later he was transferred to another hospital rapidly convalescing.

Case of Fistula of the Stomach—Ball removed from the Thoracic Cavity. *By* ELI MCCLELLAN, *Assist. Surg. U.S.A.*

Lieut.-Col. Chambers, 23d Mass. Vols., wounded May 16, 1864, at Drury's Bluff, Va., by a Minié rifle ball, which entered in front, between the fifth and sixth ribs, four inches to the left of the median line, and lodged in the thorax.

June 9th—twenty-fourth day after the receipt of the injury—the ball was removed from the chest by Assist-Surg. McClellan, in charge of the hospital. The operation for its removal was made at the seventh intercostal space, posteriorly, six inches to the left of the median line.

July 1, it was ascertained that food received into the stomach escaped by the posterior wound in the chest. Subsequently the patient's stomach became exceedingly irritable, refusing to retain nourishment of any kind, and he was for a time sustained by nutrient enemata alone.

July 15th.—Died apparently from exhaustion.

Autopsy.—Anterior wound closed. Posterior wound nearly closed. Left lung tuberculous; adherent to diaphragm and ribs; lungs not perforated by the ball. There was a fistulous opening passing from the stomach, near its cardiac orifice, through the diaphragm, to the opening made in the chest for the removal of the ball.

MAGGOTS.—At our request Dr. Sebastian Amabile, one of

the House-Surgeons of Bellevue Hospital, made a series of careful experiments to determine the relative value of various articles in destroying maggots, and with the following results:—

Spirits of turpentine does not destroy them unless employed of a strength which would prove hurtful to most raw surfaces.

The vapor of ether is harmless to them.

The vapor of chloroform kills them very quickly. This vapor is heavier than the atmospheric air, but it is found difficult to bring it to bear effectively upon the insects by simply holding a cloth or sponge saturated with chloroform over them. Dr. Amabile, however, obviated this difficulty by a very simple contrivance. He constructed a tube of gutta-percha—glass, or even pasteboard might answer the same purpose—and then placing a small bit of sponge in the tube near the junction of its lower with its middle third, he was able, by blowing into the upper end, to direct the vapor upon any point he desired.

A solution of creasote in water, twenty drops to the ounce, destroys maggots in about fifteen minutes.

A solution of creasote, forty drops to the ounce, destroys them in seven minutes.

A solution of twenty drops of creasote with twenty drops of chloroform to one ounce of water, kills them in from four to five minutes.

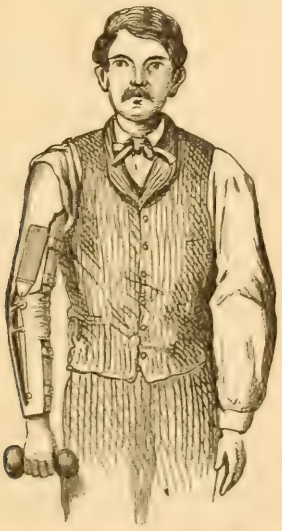
In our experience the creasote of the strength here directed has never failed to kill the maggots, while it seldom acts injuriously on the tissues; indeed, it is in most cases a useful stimulus to the granulations as well as a disinfectant; and we think the flies never deposit their eggs so long as the odor of the creasote remains. We injected the weak solution of creasote as directed by Dr. Amabile, into an abscess of the liver, which was infested with maggots; on the following day the maggots were found discharged from the cavity, with the pus, dead.

Dr. Hudson's *Apparatus for Supporting the Arm after Exsection of the Elbow-Joint.*

This ingenious contrivance, and which has recently been applied with great advantage to a case of our own, and also to a case in which Dr. Cutter, A. A. Surg. U.S.A., removed the entire humerus, is thus described by Dr. Hudson:—

"An enveloping aponeurosis for the arm and forearm, to prevent the displacement of muscles, extending from the shoulder to the elbow and from thence to the wrist, united longitudinally with clasps, and supplied with a ginglymoid articulation at the elbow. Elastic rubber bands attached to the apparatus by cords, and passing over pulleys, assist the motions of flexion, extension, and rotation."

We need scarcely say that no such apparatus will be required where the insertions of the brachialis anticus,



DR. HUDSON'S APPARATUS FOR SUPPORTING THE ARM AFTER EXSECTION OF THE ELBOW-JOINT.

biceps, and triceps have not been disturbed, and their functions remain unimpaired.

Colored Troops.—Since August, 1863, there have been enlisted into the service of the United States army, eighty thousand colored troops, most of which were at the time of the commencement of the war slaves. A large proportion of these men are of mixed blood.

This being the first time in which this class has been employed upon a scale of any considerable magnitude in the prosecution of civilized warfare, their economic value in the construction of armies remains with many still a matter of doubt.

We desire, therefore, to communicate what little information we possess upon the subject, believing that it may serve some useful purpose to those who desire to pursue the investigation.

In relation to the camp police of the colored troops we have had but little personal experience. In the performance of our duty as Medical Inspector, U.S.A., we had occasion to visit the camp of a newly recruited regiment of colored troops, stationed at Estell Springs, Tenn. The regiment numbered over one thousand men. We found the police as complete as in any of the older regiments, and the surgeon informed us that the sick reports did not exceed eight or ten daily. We have noticed the same attention to police in other smaller detachments on the field and in their hospital wards whenever we have visited them.

We have been informed by all the officers with whom we have conversed, that they readily acquire the rudiments of the art of war, such as the manual of arms and the drill. They are remarkably subordinate, and submit cheerfully to discipline. Intemperance is comparatively a rare vice among them. In all these respects they compare favorably with white troops.

In relation to their endurance in long marches, the testimony is at present insufficient to enable us to form an opinion. They have not, as a general rule, been subjected to very severe tests in this respect, most of them being sta-

tioned permanently at Posts in various parts of the country. They are also mostly new troops, and for this reason they have not had the training, nor has it been thought advisable to subject them to severe campaigning service. Some of the writers, however, who have alluded to this subject declare that they do not straggle as much as other troops, and possibly because, in the cases referred to, they entertained a greater dread of falling into the hands of the enemy.

In the trenches and as laborers in the construction of roads and bridges, in the felling of trees, and in the performance of all kinds of fatigue duty, they have generally exceeded expectation. At Yorktown, in August and September, 1862, a large number of negroes not yet enlisted as soldiers, most or all of whom were fugitives, were employed by Major-General Keyes in razing certain forts and other earthworks. At the same time a number of white soldiers were employed in a similar manner upon other field-works. We visited both detachments at different times, and observed that the negroes worked more steadily and accomplished more in a given number of hours than the white soldiers. Major-General Gillmore has also informed us that while in command of the land forces in front of Charleston the engineers constantly called upon him for his black troops for fatigue duty; they would not accept of any others. It was on this occasion that this distinguished officer was censured by some of the letter-writers for withdrawing his black troops from ordinary field and picket duty and confining them too much to the trenches. His practice, however, in this respect, was in strict accordance with a well understood rule in the military service, that raw troops should not be placed in positions of responsibility, or sent to the front, except in a case of necessity.

It is well known that negroes, and especially slaves, do not successfully compete with white labor under ordinary circumstances. They seem to possess less physical endurance, and they exhibit less inclination for work. It is our

opinion that if, as soldiers, they accomplish more in the trenches than white men, it is because the latter consider this occupation menial and unbefitting a soldier; while the negroes, and especially the freedmen, have little or none of that sentiment which regards labor under any circumstances as degrading.

On the question of the relative sickness and mortality among the white and colored troops, the testimony is very conflicting.

A gentleman writing from City Point, Va., to the U. S. Sanitary Commission, under date of September 26, 1864, states:—

"The testimony of all observers here, as well as at the South and South-west, is, that the mortality among the colored troops is, relatively to that among white soldiers (where both have the same shelter and equal medical attendance), alarmingly in excess.

"These gentlemen, after making all proper (and very great allowance) for the morbid depression which always succeeds in the uneducated negro to the loss or suspension of physical health and enjoyment, yet suggest the inquiry —Whether the same pains have been taken and the same success obtained, in supplying the prophylactic diet referred to above, to the colored as to the white men?

"I am very authentically informed, too, to-day, on the testimony of a Virginian, long familiar with the region along the James and Appomatox, that the peculiar malaria of these farms has been proverbially fatal to black men."

The editor of the Sanitary Com. Bulletin, commenting upon this letter, says:—

"The greater mortality of colored troops, under similar circumstances of diet and exposure with white troops, is an interesting inquiry for physiologists and philanthropists. It is well known that the percentage of death among negroes in penitentiaries is in excess of white prisoners, with the same treatment.

"We doubt very much if the difference in the army is accounted for by any lack of care of negro troops."

Lieut. S. P. Thompson, a very intelligent officer of the 2d regiment, U. S. Colored Troops, informs us, in a letter dated Nov. 2, 1864, that the men of his regiment are mostly from Maryland and Virginia, and about three-fourths of them are thoroughly African. They have been stationed mostly along the Gulf of Mexico, in New Orleans, and lately at Key West, Florida.

They are very sensitive, he remarks, to cold and wet weather, and peculiarly prone to attacks of pneumonia and other diseases of the lungs; but in other respects they are no more liable to sickness than other troops, and their diseases are generally of a light character. They seem to be equally liable to yellow fever as the whites, but the attacks are much less often fatal. Of two hundred and fifty colored soldiers who contracted the fever, only six or seven died; while during the same period fourteen officers died, of whom twelve belonged to his regiment.

"We have had but little marching to do, but I think them equal to white troops in this particular. They are generally strong and healthy."

The following letter is from a medical officer in charge of the colored wards at Hampton Hospital, near Fortress Monroe. This may be regarded as a "base" hospital, most of the patients being received from the army in front of Richmond within a few hours after the receipt of their injuries. It is one of the largest hospitals in the U. S., and is under the excellent management of Assist. Surg. Eli McClellan, U.S. A. The wards are mostly pavilions, and those occupied by the white and black troops are upon the same ground and under the same hygienic influences. The police and discipline are admirable.

"U. S. General Hospital, Fort Monroe, Va.,
"October 26th, 1864.

"Doctor Frank H. Hamilton:—

"Sir,—In accordance with your request, I take pleasure in making the following condensed statement of results from gunshot and other wounds, in my wards in this hospital, during the last five months; during which time I have had the care of over one hundred cases of amputation of upper and lower extremities. In the colored wards under my charge, amputations of arm and forearm have generally healed in a great measure by first intention; but two cases of arm amputations have proved fatal, both of which were secondary operations, and were complicated by other difficulties.

"In amputations of leg and thigh, about one half of the primary operations healed in part by first intention. In forty amputations of leg and thigh, but three cases of primary operations proved fatal, one case of which had the arm amputated also. I have had ten cases of amputation of the leg in which the rectangular incisions were made, none of which healed by first intention, but in most of them there was extensive suppuration and sloughing of the flaps. Of six cases of amputation of the leg by the circular method which were treated in my ward, all healed in great measure by first intention. These were primary operations. Of twelve cases of amputation of the thigh—secondary operations—after extensive injuries of the knee-joint, five proved fatal. Flap operations have generally done better than circular, especially in healing by first intention. But one case of secondary hæmorrhage has occurred after a flap operation, while several have occurred after circular. To be brief, my experience, after having charge of both white and colored wards, is that colored soldiers' wounds and amputations do better and heal more generally by first intention than white soldiers'. All the

cases I have mentioned occurred among the colored soldiers.

"Very respectfully your obedient servant,

"A. B. CHAPIN, *Acting Assist-Surg., U.S.A.*

"P. S.—As regards the liability of colored soldiers to hospital gangrene, I would say, that after having had in my care over two thousand colored patients with gunshot and shell wounds, I have never had a well marked case of hospital gangrene amongst them, while amongst the white wards there has been considerable hospital gangrene the past summer."

ADDITIONAL NAMES OF KILLED AND WOUNDED MEDICAL OFFICERS.—Olinslaughter, Surgeon U.S.V., Medical Director to Major-General Torbert's Division; killed near Winchester, Va., Oct. 11, 1864. He was attacked by a party of guerillas, and having surrendered was shot through the abdomen, dying soon after in great agony.

Rulison, Surgeon on General Torbert's Staff, was killed near Smithfield, Va., by a sharpshooter, Aug. 29, 1864, while riding along the skirmish line, in company with the General.

Jenkins, Surgeon, killed Oct. 20, 1864, at Cedar Creek, Va., in a night attack made by the enemy.

Samuel W. Everett, Surgeon, killed at the battle of Shiloh, Tenn., April 6th, 1862.

Danker, Act. Assist.-Surg. U.S.N., was lost when the gunboat Tecumseh ran upon a torpedo and went down with all on board, in the bay of Mobile, Aug. 5, 1864.

F. H. Gross, Surgeon of V., and Medical Director of Corps, wounded in the head severely, at the battle of Chicamauga, Ga., 1863.

Shannon, Surgeon of 19th Ohio V., wounded in three places, Oct. 20th, 1864, at Cedar Creek, Va.

R. S. Vickery, Assist.-Surg, 2d Mich. Vol., wounded by a rifle ball, July 30, 1864, before Petersburg, Va., while in the rear of his regiment dressing the wounded. The

ball penetrated the left thigh, wounding the femoral artery one inch below the profunda. The bleeding was arrested temporarily by a tourniquet, and three hours after Surgeon Fox, of the 8th Michigan, enlarged the opening and tied the femoral, both above and below the seat of injury.

Aug. 18th, 1864, we saw Assist.-Surg. Vickery in the Officers' Hospital, N.Y., with the wound nearly closed.

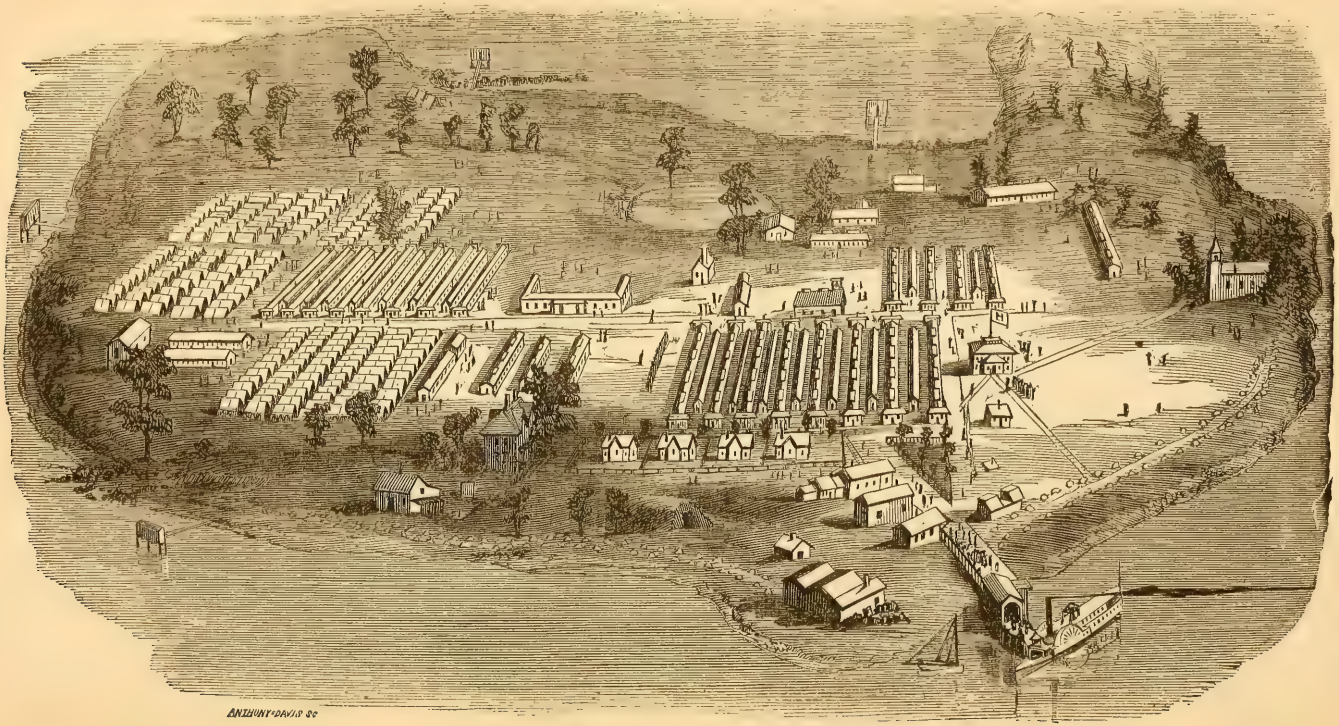
N. R. Derby, Surgeon U.S.V. and Medical Director, wounded by a rifle ball while in the act of dressing a wounded man on a gunboat, on the Red River, in 1864. The ball entered the sacrum and lodged in the cavity of the pelvis. This gentleman, one of our most valuable medical officers, is at this moment under our care, the ball not yet having been found.*

De Camp General Hospital, U.S.A.—De Camp General Hospital, U.S.A., situated upon David's Island, in the East River, and about fifteen miles above the city of New York, contains three thousand five hundred beds, and is therefore one of the largest military hospitals in the world. It is composed mostly of pavilions, constructed with the utmost care, and with reference solely to the health and comfort of the patients. Recently a considerable number of hospital tents have been added, for the purpose of increasing temporarily its accommodations.

This hospital is at present under the charge of Assistant-Surgeon Webster, U.S.A., late of the McDougall General Hospital.

We are happy to be able to furnish our readers with the accompanying excellent wood-cut, presenting a view of the entire island and its buildings.

* No attempt has been made to prepare a complete record of all the medical officers killed and wounded during the present war. We have only mentioned such examples as have come incidentally to our knowledge, and it is believed that these are but a fraction of the whole number.



DE CAMP GENERAL HOSPITAL.

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